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Our collector made a ten-day trip to the locality, far from the railroads in the Pine Ridge Indian Reservation. These remarkable crystals have been investigated crystallographically by Prof. S. L. Penfield (this Journal) and their mode of occurrence described by Prof. E. H. Barbour (Bull. Geol. Soc. Am.)

The locality was well worked and only the best portion of the crystallizations handled were saved. By far the largest lot ever brought from the locality was shipped. It embraces the loose doubly terminated steep hexagonal pyramids as well as hundreds of clusters and concretions of the same, 2 to 10 inches diameter. The low prices include but one profit. They have not been handled by two dealers, as was a lot formerly retailed.

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THE

AMERICAN JOURNAL OF SCIENCE

[FOURTH SERIES.]

ART. XXXIV.—*Mineralogical Notes;* by C. H. WARREN.

I. *Native Arsenic from Arizona.*

A RECENT discovery of native arsenic at Washington Camp, Santa Cruz Co., Arizona, adds still another interesting occurrence of this mineral in North America to those already recorded.

We are indebted to Mr. George A. Lonsbery, superintendent of the Double Standard Copper Mine, now operated by the Copper Century Mining Co. of Boston, Mass., for calling the attention of Professor W. O. Crosby of the Massachusetts Institute of Technology to the occurrence, and for generously presenting him with the best and largest part of the find. The specimens, together with the following data regarding its occurrence, were very kindly placed with the writer for study by Professor Crosby.

The arsenic occurred in reniform masses attached to the walls of a small pocket in a dolomitic limestone. The pocket was situated in close proximity to an important fault at a depth of about sixty feet. Many of the masses are remarkably fine ones, weighing in some instances several pounds, while the aggregate weight of the arsenic was something over fifty pounds. The limestone of the region is highly metamorphic and is traversed by two parallel and closely adjoining veins of copper ore (chalcopyrite, sphalerite and some galena with a gangue of garnet, quartz and calcite) on which some development has been done. The faulted zone is characterized by considerable brecciation. Masses of igneous rock, granite and an acid porphyry outcrop in the immediate neighborhood, and their intrusion is undoubtedly closely connected with the formation of the ore-bodies, and also with the subsequent faulting.

The reniform masses, as is usual with native arsenic, are black in color, or gray on freshly broken surfaces, and consist of many thin concentric layers. While no distinct crystallographic outlines can be seen, each layer appears to be made up of semi-crystalline arsenic having a prismatic structure normal to the surface. What appear to be extremely small prismatic crystals have been noticed in a single instance. The masses are considerably fissured and the openings thus formed have been largely filled with later minerals, which also appear abundantly on the surface and in the solution cavities mentioned beyond. Of these minerals quartz and calcite are the most abundant, the former as small but well-terminated prismatic crystals, the latter in a slightly discolored, massive crystalline form.

1

Fig. 1. Side view.

2

Fig. 2. Top view.

The arsenic has been attacked to a considerable extent by some solvent. This has removed portions of the arsenic by attacking first the edges of the layers, where these were exposed by a fissure. It then encroached gradually on the substance of the layers by dissolving out narrow channels varying in width from that of a line to 0·5^{mm}. These channels ramify into networks, which give rise to an appearance suggesting that of a finely sun-cracked piece of mud. This

appearance is illustrated by figs. 1 and 2. The outlines of each layer are marked by extremely thin but distinct shells, in many instances also curiously corroded, which represent the more refractory upper surface of each layer. The distances between such shells indicate a thickness for the original layers of from 0·2 to 1·5^{mm}.

Associated with the quartz and calcite, and evidently of the same age, is a little reddish sphalerite and minute crystals of iron pyrite. (Iron pyrite also occurs abundantly in the wall of the pocket.) In a vein of quartz traversing one specimen, extremely minute, gray prismatic crystals of arsenic are embedded, and on the reniform surface of the same specimen can be seen a light gray druse of arsenic. This arsenic is clearly of the same age as the quartz and indicates that the same solutions which deposited the quartz were carrying some arsenic, evidently derived directly from the reniform masses.

Careful qualitative tests showed the presence of a small amount of antimony and a trace of sulphur in the arsenic.

N. N. Evans,* in a recent description of native arsenic from a vein traversing a nepheline-syenite rock in the vicinity of Montreal, attributes its formation there to deposition by fumarole action. It is believed that a similar method of formation obtained for the Arizona arsenic. Gaseous emanations, carrying some volatile arsenic compound, may very probably have escaped from underlying igneous rocks into a pocket in the limestone, and finding there, as suggested by Professor Crosby, a local relief of pressure, decomposed and deposited successive layers, eventually forming the reniform masses. After their formation these were fissured to some extent by shrinking but chiefly through movements connected with the faulting. Subsequently, solutions carrying silica, carbonate of lime, and a small amount of sulphides removed a portion of the arsenic and deposited the minerals named.

The author is indebted to Mr. John L. Gardner of Boston for the very excellent photographs from which the present figures were taken.

II. *Anthophyllite with the Fayalite from Rockport, Mass.*

During the fall of 1902 a mineral was submitted to the author for identification by Messrs. F. W. Horton and Cutler D. Knowlton, students in the Massachusetts Institute of Technology. The mineral was found by them in the quarries of the Rockport Granite Co. at Rockport, Mass., and proved to be fayalite, the first occurrence of which was described by Penfield and Forbes,† who analyzed it and established the optical constants for the species.

* This Journal (4), xv, 92. † This Journal (4), i, 129.

It is the object of this paper to once more call attention to the remarkable occurrence of this rare mineral, and to describe an interesting zone of a new fibrous amphibole which has resulted from the reaction between the silica of the enclosing pegmatite and the fayalite.

The fayalite of this second find appears to be identical in character, and in its general mode of occurrence, with that described by the authors cited above, although it was somewhat larger in size. The several large and fine specimens, which the discoverers very kindly brought to the author for examination, indicate clearly that the mass was roughly lenticular in form, having a maximum thickness of about ten inches and tapering from this to an edge of about 0·5 inches. Mr. Horton states that about 250 pounds was taken out in all, and that it was entirely surrounded by the pegmatite, portions of which still adhered to the specimens studied. The mineral was for the most part fresh, showing, however, in some of the thinner portions alteration to a brown ferruginous powder.

Magnetite occurs chiefly as a marginal secretion. A narrow granular rim never exceeding a few millimeters in width practically surrounds the fayalite, while single grains often attaining a diameter of 4^{mm} are often observed near the outside of the mass.

Thin sections examined under the microscope show that magnetite is quite plentifully scattered through the fayalite in the form of very minute grains, which have the characteristic cross sections of magnetite. The grains are frequently arranged in rows, which extend across the fayalite very much in the way that inclusions do in the quartz of many rock sections.

Where the fayalite comes in contact with the quartz of the pegmatite, a reaction rim is developed consisting of radial fibrous aggregates. The fibers shoot out into the fayalite on one hand and into the quartz on the other. The line of separation which marked the original contact is distinct, and passes through the centers of the radial groups. The zone varies in width from 3 to 8^{mm}, although in one instance, where an overlapping of an edge of the fayalite had occurred, a mass of fibrous mineral some 3^{cm} in thickness was observed.

The fibers are translucent, white to a light brown in color, and at once suggest anthophyllite by their appearance. On the side toward the fayalite, magnetite grains are embedded in the mass of fibers, which, as will appear later, are residual after the alteration of the fayalite to anthophyllite. The mineral is seen both in radiating groups and as isolated fibers in portions of the fayalite near the margin, but none has been observed at a greater distance than three or four centimeters from it. The larger magnetite grains usually act as the center for a group of

radiating fibers. Thin sections from such portions show clearly that the fayalite has been altered by mineralizing solutions which gained access along crevices, cleavage cracks, or along the lines of magnetite inclusions, evidently drawn in by the force of capillary action. Every stage in the alteration of the fayalite can be seen, from that of the pure iron silicate with only now and then an encroaching fiber of anthophyllite, through those stages where patches or islands of fayalite are entirely surrounded by the secondary fibers, to the stage where the change is complete and the field is entirely composed of anthophyllite with grains of residual magnetite. The magnetite shows no evidence of having played a part in the reaction other than to serve as nuclei for the radiating groups of fibers.

Under the microscope between crossed nicols, the fibers show parallel extinction, a fairly high single and a high double refraction. Cross sections of a group of fibers show that each one is a minute prismatic crystal of an amphibole, the sides of the prisms making angles that measured approximately 123 and 57 degrees. A careful study of prismatic and basal sections was made in parallel polarized light with a quartz wedge in order to determine the position of the different vibration directions. The following relations were established; $c=\mathfrak{a}$, $a=\mathfrak{c}$, $b=\mathfrak{b}$, axial plane parallel to the brachypinacoid. In convergent light a biaxial interference figure is obtained from sections parallel to the macropinacoid. The axial angle is large, the loci of the hyperbolas lying just in the edge of the field of the microscope. The character of the double refraction is positive and the dispersion is well marked, red less than violet.

Basal sections are also confirmatory of the above since they show the central portion of an obtuse interference figure.

Before the blowpipe the fibers blacken, round slightly and become strongly magnetic. They are insoluble in acids. Careful qualitative tests show the mineral to be a practically pure iron silicate, with only traces of aluminium and magnesium. It seems, therefore, that the fibers are those of a pure iron anthophyllite, and represent a new member of the amphibole group. The formation of this metasilicate of iron from the orthosilicate by the addition of SiO_2 derived from the pegmatite, may be illustrated by the following equation:

$$\underset{\text{Fayalite}}{Fe_2SiO_4} + SiO_2 = \underset{\text{Anthophyllite}}{Fe_2Si_2O_6}$$

A quantitative analysis to verify the above conclusion is desirable, and it is hoped that the time and facilities for making it may soon be available.

Intimately associated with the anthophyllite is a dark green lepidomelane mica. It usually lies with its cleavage faces

parallel to the surface, although it is occasionally seen lying along cleavage planes in the fayalite. On one specimen where a considerable amount of the lepidomelane was developed, a large number of zircon crystals, one to three millimeters in diameter, were embedded. The mica corresponds to the variety annite, described from this locality by Cooke.* It fuses to a black magnetic globule, gelatinizes with acids, and reacts for aluminium, potash, and a little magnesium. Its axial angle in oil (refractive index 1·515) was found to be 8°—24′. This mica is probably not a reaction product like the anthophyllite. It is present in other parts of the pegmatite of the quarries, and its occurrence in connection with the fayalite is indicative of nothing more than of the tendency of the ferromagnesian and other minerals belonging to an early period of crystallization to collect about anything that might have induced crystallization, in this case the mass of basic iron silicate. The presence of the zircon strengthens this view.

Two theories may be advanced regarding the origin of the Rockport fayalite; first, that it is a basic inclusion which has been thoroughly fused and recrystallized under conditions which led to the development of a coarsely crystalline texture like that of the pegmatite itself, during which process of crystallization the magnetite segregated toward the margin and the anthophyllite was developed: second, that the fayalite was formed from the pegmatite by the action of superheated vapor or steam under pressure as suggested by Iddings† for the fayalite crystals occurring in the lithophyses of the obsidian of the Yellowstone National Park. After its formation and segregation, the temperature and pressure diminished, allowing the crystallization, etc. It is perhaps hard to understand just how the segregation took place, and if it did, it would seem as if smaller masses of a similar nature should exist in the pegmatite. None have been found, however, except the one before alluded to.

In favor of the inclusion theory may be cited the occurrence of fayalite described by Gmelin.‡ He describes the mineral as an enclosed mass in trachytic lava at Fayal. It is stated that the mass showed evidences of fusion and that it was filled with bubbles in places. There is a possible analogy between the two occurrences.

The inclusion theory calls for the existence of a rock which is nearly a pure orthosilicate of iron in composition, a supposition that seems rash. The second theory seems the most reasonable to the author.

*This Journal, xliii, 222, 1867.

† U. S. G. S., 7th Ann. Report, p. 280.

‡ Chemische Untersuchung des Fayalits, Poggendorff Annalen, li, 160, 1840.

The author wishes here to thank Messrs. Horton and Knowlton for generously furnishing him with the material for study.

III. *Cerussite and Phosgenite from Colorado.*

In making blowpipe tests on some specimens of cerussite it was noticed that when the finely-powdered mineral was heated on a platinum wire in the Bunsen flame, after the color due to the lead had disappeared, a persistent crimson coloration was imparted to the flame, indicating the presence of strontium.

The cerussite was purchased from Messrs. George L. English & Co. of New York, and through their courtesy it was learned that it came from the Terrible mine, Isle, Custer Co., Colorado.

It is crystalline and massive in character, of a prevailing grayish white color, which changes in places to a light amber tint. The surface is discolored with a yellowish brown earthy coating.

A chemical analysis* made on carefully selected fragments, having a specific gravity of 6·409, yielded the following results:

		Ratio.	
CO_2 = 17·02 ÷ 44	= ·387	·387	
PbO = 79·59 ÷ 223	= ·357	·387	
SrO = 3·15 ÷ 103·3	= ·030		
Alks. trace.			
FeO trace.			
99·76			

Careful tests were made for barium and calcium with negative results. The ratio is very sharp, $PbO + SrO : CO_2 = 1 : 1$, and indicates the formula $(Pb, Sr)CO_3$ for the mineral. Calculated to one hundred per cent, the composition becomes $PbCO_3 = 95{\cdot}52$ per cent; $SrCO_3 = 4{\cdot}48$ per cent. No strontium could be detected in the phosgenite.

It is, perhaps, not surprising to find such a notable amount of strontium carbonate isomorphous with the lead carbonate, but, so far as the author has been able to ascertain, it is the first recorded instance of such a carbonate, and adds another undoubted case of isomorphism to those already known among the orthorhombic carbonates.

By plotting the specific volumes (the specific gravity of lead and strontium carbonates being taken as 6·517 and 3·697 respectively) of lead and strontium carbonates as ordinates and the percentages of strontium carbonate as abscissas, a specific grav-

*The analysis was made by the author while he was connected with the Mineralogical Laboratory of Sheffield Scientific School, during the spring of 1900.

ity of 6·329 was calculated for a carbonate having the same composition as that of the one analyzed. This compares very satisfactorily with the actual specific gravity, 6·409.

Associated with the cerussite is the chlor-carbonate of lead, phosgenite. This is distinguished in appearance from the cerussite by its clear brown color and by three excellent cleavages, prismatic and basal, at right angles to each other. It was possible to identify the basal cleavage by the positive uniaxial interference figure obtained when sections parallel to this cleavage were examined under the microscope. On such fragments a much poorer cleavage approximately half way between the prismatic cleavages was also observed, indicating the presence of the cleavage parallel to the face 100. The prismatic and basal cleavages are of about the same degree of perfection. In one specimen a somewhat tabular habit was noticed parallel to the basal cleavage.

The relative amounts of cerussite and phosgenite vary considerably in different specimens, but the latter has always been observed as a core surrounded by the former. In one specimen, weighing nearly two pounds, the cerussite is simply a rim averaging 1^{cm} in thickness. This is separated from the phosgenite by a very narrow white band of powdery material. The above facts suggest that the cerussite is an alteration product of the phosgenite. Small cavities, possibly formed by solution, lined with minute acicular crystallizations of cerussite have been noticed on most of the specimens examined.

Contributions from the Geological Department of the Massachusetts Institute of Technology, No. 116, vol. 15.

Boston, Mass., June, 1903.

EXPLANATION OF PLATE XVI.

Cheiromys madagascariensis, the Aye Aye. (After Owen.)

EXPLANATION OF PLATE XVII.

Cheiromys madagascariensis, the Aye Aye; showing the slender third digit of the hand. (After Owen.)

ART. XXXV.—*Studies of Eocene Mammalia in the Marsh Collection, Peabody Museum;* by J. L. WORTMAN. (With Plates XVI and XVII.)

[Continued from vol. xv, p. 436.]

THE first suborder, or the Cheiromyoidea, is of great interest, inasmuch as it numbers among its representatives the very curious and interesting creature commonly known as the Aye Aye, now living in Madagascar (Plates XVI and XVII). This species was first brought to the attention of naturalists by the French traveller Sonnerat more than a hundred years ago, and was for a long time looked upon as belonging to the order Rodentia, or the Gnawers, closely allied to the squirrel.

In 1862, Richard Owen received a specimen of the animal, and from a careful study of its anatomy conclusively demonstrated its lemurine affinities. As we have already seen, the character of its incisors and the form and general make-up of its jaws are exceedingly like those of the rodents; but in the complete bony ring surrounding the orbit, as well as in the prehensile extremities and the remainder of its anatomical structure, it bears the unmistakable stamp of its Primate relationship.

The hands are long and slender and the fingers are provided with claws. The third digit of the manus is curiously modified, in that while of the same proportional length as the others it is exceedingly slender. It has, indeed, been aptly compared to a wire with a hook at its end. The animal is nocturnal in its habits, inhabiting the dense forests of Madagascar, where it is said to be rare.

The specimen which was sent to Owen was kept in captivity for some time, and Dr. Sandwith, who obtained the animal, was enabled to learn its curious habits. He wrote as follows: "I observe he is sensitive of cold, and likes to cover himself up in a piece of flannel, although the thermometer is now often 90° in the shade. He is a most interesting little animal, and from close observation I have learned his habits very correctly. On receiving him from Madagascar, I was told that he ate bananas; so of course I fed him on them, but tried him with other fruit. I found he liked dates,—which is a grand discovery, supposing he be sent alive to England. Still I thought that those strong rodent teeth, as large as those of a young Beaver, must have been intended for some other purpose than that of trying to eat his way out of a cage—the only use he seemed to make of them, besides masticating soft fruits. Moreover he had other peculiarities,—*e. g.*, singularly large, naked ears, directed forward, as if for offensive rather than defensive purposes;

then, again, the second finger of the hands is unlike anything but a monster supernumerary member, it being slender and long, half the thickness of the other fingers, and resembling a piece of bent wire. Excepting the head and this finger, he closely resembles a Lemur.

"Now, as he attacked every night the woodwork of his cage, which I was gradually lining with tin, I bethought myself of tying some sticks over the woodwork, so that he might gnaw these instead. I had previously put in some large branches for him to climb upon; but the others were straight sticks to cover over the woodwork of his cage, which *alone* he attacked. It so happened that the thick sticks I now put into his cage were bored in all directions by a large and destructive grub, called here the *Moutouk*. Just at sunset the Aye-aye crept from under his blanket, yawned, stretched, and betook himself to his tree, where his movements are lively and graceful, though by no means so quick as those of a Squirrel. Presently he came to one of the worm-eaten branches, which he began to examine most attentively; and bending forward his ears, and applying his nose close to the bark, he rapidly tapped the surface with the curious second [third] digit, as a Woodpecker taps a tree, though with much less noise, from time to time inserting the end of the slender finger into the worm-holes as a surgeon would a probe. At length he came to a part of the branch which evidently gave out an interesting sound, for he began to tear it with his strong teeth. He rapidly stripped off the bark, cut into the wood, and exposed the nest of a grub, which he daintily picked out of its bed with the slender tapping finger, and conveyed the luscious morsel to his mouth.

"I watched these proceedings with intense interest, and was much struck with the marvellous adaptation of the creature to its habits, shown by his acute hearing, which enables him aptly to distinguish the different tones emitted from the wood by his gentle tapping; his evidently acute sense of smell, aiding him in his search."

I have quoted thus at length these interesting observations upon the grub-eating habits of the Aye Aye, for the reason that there can be no doubt, apparently, that they are directly responsible for the rodent-like character of the incisors, as well as for the tendency to degeneration and reduction of the molars and the curious modification of the third finger of the hand which is made to fulfil the functions of a probe, plexiimeter, and scoop. We shall presently see in what way these modifications throw light upon some of the extinct American forms of this same group.

The chief diagnostic features of the suborder have already been given, and to these should be added the lack of bony

union of the two rami of the lower jaw, as in the Rodentia. It is probable that this condition is in some way correlated with the enlargement of the incisors and their final growth from persistent pulps, as seen in the most advanced species. Of the extinct American forms, I recognize two groups, which, on account of the wide differences between them in point of structure, I classify in two distinct families. The structure of one of these groups is imperfectly known, and it is impossible to state with certainty whether or not they are Primates. Osborn has recently proposed* to arrange them as a primitive suborder of the Rodentia, Proglires, but there are so many serious objections to such a view that I choose to regard them as Primates allied to *Cheiromys*. My reasons for such a course will be given after the species have been described.

The suborder as thus constituted includes three families, defined as follows:

Incisors reduced to a single pair above and below, enlarged, faced with enamel, and growing from persistent pulps, rodent-like; premolars reduced to one above and absent below; molars quadritubercular above and below, and rodent-like in pattern, with tendency to degeneration. Cheiromyidæ.

One pair of incisors above and below, enlarged, recurved, transversely compressed, and slightly twisted; crowns sheathed with enamel, not growing from persistent pulps, and altogether unlike those of rodents; cheek teeth in lower jaw reduced to two small styliform rudiments inserted immediately behind the large incisors; upper cheek teeth unknown. Metacheiromyidæ.

One to three pairs of incisors in the lower jaw, with central pair enlarged, having distinct roots, and with crowns sheathed in enamel; premolars never less than two in lower jaw; molars tritubercular above, with fourth cusp rudimentary; anterior cusp of trigon present in lower molars; fourth premolar becoming molariform above and below. Microsyopsidæ.

Family Metacheiromyidæ fam. nov.

Metacheiromys Marshi gen. et sp. nov.

The remains upon which this family and genus are founded consist of a single specimen of a fragmentary skeleton, which includes the two upper incisors, with a portion of the premaxillary attached; portions of the back and base of the skull, including an otic bulla; one mandibular ramus, with the entire tooth-border preserved; the bodies of nearly all the cervicals; a few dorsals and caudals; some ribs; the glenoid cavity of the scapula; the proximal and distal ends of a humerus; the proximal and distal ends of an ulna; the distal end of a radius; a portion of the pelvis, and the proximal and distal ends of a tibia.

* American Eocene Primates, etc., Bull. Amer. Mus. Nat. Hist., June 28, 1902.

The superior incisors, figure 105, more nearly resemble the upper canines of *Hapalemur griseus* than any other teeth with which I have been able to compare them. They are, however, less pointed, somewhat thicker in front, and have a decided twist. The office of this torsion was doubtless to bring into apposition flatwise the points of the two teeth implanted by diverging roots. Both the crowns and the roots are considerably compressed from side to side, the crown terminating behind in a sharp cutting edge. In cross section, therefore, the tooth gives an elliptical outline, pointed behind. There is a worn surface upon the front face of the crown, showing the point where it most frequently impinged upon the lower incisor. The crown is completely invested with enamel, and the tooth was implanted by a distinct root and was therefore of limited growth. The remaining cranial fragments furnish little information of the general skull structure further than that there was a well-ossified tympanic bulla more or less filled with cancellous tissue.

105

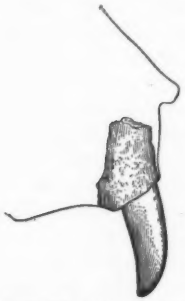

FIGURE 105. — Superior incisor of *Metacheiromys Marshi* Wortman; side view; natural size. (Type.)

107

106

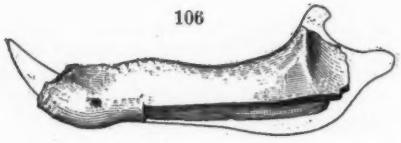

FIGURE 106.—Lower jaw of *Metacheiromys Marshi* Wortman; side view. (Type.)

FIGURE 107.—The same jaw; viewed from above.

Both figures are one and one-half times natural size.

Although not complete, the lower jaw, figures 106 and 107, exhibits some remarkable characters. Posteriorly the lower edge is broken away, as well as the coronoid, condyloid, and angular regions. The front third, however, is entire, and in this part the ramus displays an unusual lack of depth, but is of normal transverse thickness. This latter dimension is consider-

ably augmented in the region of the implantation of the single enlarged incisor. The crown of this tooth is not preserved, being broken away at the level of the alveolus. The root is suboval in cross section, with a rounded angular part internal. Projecting the contour of the broken part of the jaw from that which is preserved, the horizontal ramus is seen to be rather shallow and slender. There was a well-developed masseteric fossa, the anterior portion of which is shown in the specimen. That which may be regarded as the most extraordinary feature of the jaw is the practical absence of cheek teeth. The dentinal border is preserved entire and in this are to be seen two shallow sockets, the first of which is situated immediately posterior to the enlarged incisor. After a short interval behind, a second similar alveolus occurs, and it is perfectly evident that these served for the implantation of two single-rooted styliform teeth, which were apparently caducous. The remainder of the tooth border was entirely edentulous. The mandibular symphysis is not rugose, and there is no trace of any tendency to coössification of the two rami.

The characters of the bodies of the cervical vertebræ are of an indifferent nature, and furnish little or no information of the affinities of the species. They are rather broad and depressed, and are without inferior keels, as in the rodents and certain lemurs, notably *Nycticebus*. The caudal vertebræ denote that there was a long tail. The ribs, as indicated by a few heads, are likewise of the usual pattern and wholly uncharacteristic.

The glenoid cavity of the scapula has a form usually seen in the living lemurs, perhaps more resembling that of *Propithecus* than any of the other existing species. It will, however, answer quite as well for that of a squirrel. The humerus, figure 108, is more characteristic, and it is in this bone that the Primate affinities begin to manifest themselves. The head is globular, somewhat pointed behind, and overhangs the shaft but slightly. The greater tuberosity rises to the level of the head, and is of considerable fore and aft extent. It equals slightly more than one-half the antero-posterior diameter of the articular portion. The lesser tuberosity is also prominent and separated from the greater tuber-

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FIGURE 108.—Right humerus of *Metacheiromys Marshi* Wortman; front view; natural size. (Type.)

osity by a distinct bicipital groove. The deltoid crest is moderate, but the extent to which it descends upon the shaft can not be determined on account of the imperfect condition of the bone. Upon the whole, its proximal end presents a very strong likeness to that of *Cheiromys* and *Propithecus* among the Primates, and differs from that of the rodents. The distal end is noteworthy for its great proportional breadth. The internal condyle is prominent, as in all early mammals. There is an entepicondylar foramen and an unusually broad supinator ridge. On account of the incompleteness of the latter, it is impossible to state whether it terminated abruptly above, as in *Cheiromys*, or sank gradually away into the shaft, as in *Propithecus* and the other lemurs. The distal articular extremity presents the usual divisions into trochlear and capitellar portions. A characteristic feature of this part of the Primate humerus is a ridge descending from the shaft in front, to become continuous with the external raised edge of the ulnar articular surface. No trace of this ridge is found in the humerus of the Rodentia, but in the fossil it is present, although not so strong as in existing lemurs and monkeys. The trochlear portion for articulation with the ulna is well rounded and terminates behind in a moderately deep olecranon depression. The capitellar portion is unusually globular and displays upon its outer side a distinct groove which extends somewhat more than halfway around the articular extremity.

Among living forms, the only case in which this groove is so well developed is in *Propithecus*. *Cheiromys*, *Galago*, and *Cheirogaleus* exhibit distinct traces of it, but it is confined to the upper outer edge of the capitellum. In *Propithecus* it is associated with a characteristic shape of the articular head of the radius, which consists of a central depression surrounded by a more or less flat ringlike area around the edge. The head of the radius is not preserved in the fossil, but the similarity in the structure of the corresponding humeral articulation leaves little doubt that its form was like that of *Propithecus*. The distal end of the humerus is thus seen to be like that of the lemurs and entirely different from that of *Paramys* and *Sciurus*, with which I have compared it.

The olecranon of the ulna is unusually long, and in this respect differs from all the modern lemurs, as well as from *Sciurus*. It is deeply grooved upon its outer side and presents an extensive, flattened, subcutaneous area upon its under side. In the first of these characters it resembles the ulna of *Propithecus*, and in the second that of *Cheiromys*. The similarity to these two genera also extends to the distal ends of both the ulna and radius.

The tibia, figure 109, is the most characteristic part of the skeleton preserved, and in the absence of the feet this bone, especially in its distal end, may be said to be one of the most distinctive of the entire Primate skeleton. The chief characteristics of the tibia in the lemurs and monkeys may be briefly stated as follows: The proximal surface is divided into two subequal articular facets, which are separated by a relatively high, pointed tibial spine. The long, straight shaft is much compressed from side to side and marked at the lower part of its upper third in front by a roughened tubercle for the attachment of the *semitendinosus*, one of the chief inner hamstring muscles. The distal extremity is relatively narrow transversely and limited internally by a large pointed malleolus. The articular surface which it offers to the astragalus is slightly concave from before backward, but in a transverse direction is almost plane and slopes outward toward the fibula. This arrangement is associated with a highly characteristic form of the astragalus, which in turn is indicative of a prehensile pes. Among the Rodentia, on the other hand, the tibia and astragalus are equally characteristic and distinctive of another type of foot. In the fossil under consideration, the tibia has every mark and feature of the Primate so unmistakably stamped upon it that I have no hesitancy in referring the species to this order, in a position not far removed from *Cheiromys*.

109

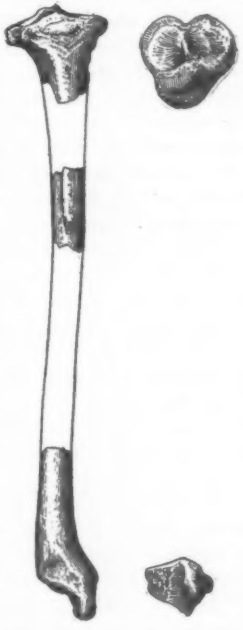

FIGURE 109.—Right tibia of *Metacheiromys Marshi* Wortman; front and end views; natural size. (Type.)

Discussion.—We have already seen that in *Cheiromys* we have an undisputed Primate, in which the incisors have undergone modification exactly similar to that of the Rodentia. We have further seen that the presence of these teeth in this animal is associated not only with a peculiar modification of the third finger of the hand, but with a grub-eating habit and a tendency to degeneration of the molars and premolars. Now in the extinct creature before us, we have, if the evidence derived from its osteology can be trusted, an equally unmistakable Primate undergoing the same modification of the incisors, and

in which the cheek teeth had almost completely disappeared. We have no information of the structure of the hand, but whether or not any of the fingers were modified in a manner corresponding to that of the Aye Aye, the practical loss of the molars and premolars can be accounted for on no other supposition than that the nature of the food upon which the animal subsisted was so soft as to require no crushing power on the part of the grinders. From what we know of the habits of the Aye Aye, the inference is both logical and natural that this food was also soft larvæ, which the animal was doubtless accustomed to seek in a similar way. From the comparative slenderness and weakness of the lower jaws, we may even further suggest that the animal captured these grubs in soft or decayed wood.

If the facts of structure have been correctly interpreted and our hypothesis in regard to the habits is well founded, what shall we say of the relationship between *Metacheiromys* and *Cheiromys?* Is it possible to suppose that these modifications, so profound and unique among the Primates, have originated twice in the same group entirely independently of each other? *Metacheiromys* can not be placed directly in the ancestral line of *Cheiromys* for the reason that by the loss of the grinders it had, in the Eocene, already reached a more advanced stage of evolution than the living genus. But to deny that the two were descended from a common ancestral stock would, it seems to me, involve such a tremendous assumption as to lay a heavy burden upon our powers of belief. Such assumption becomes all the more onerous in the complete absence of any evidence in its support. If one had no proofs upon which to base an opinion respecting the community of origin and distribution from a common center other than that afforded by these two animals, so widely separated in space and yet so closely connected in structure, he could still feel amply assured of the security of his foundations. This evidence of the relationship between the Madagascar and Wyoming species, therefore, adds but another link in the chain of proof already set forth, that both forms were migrants from a common boreal home.

Family Microsyopsidæ.

Microsyops Leidy.

The next family of this group to be considered is the Microsyopsidæ. The type genus *Microsyops* was separated and described by Leidy in April, 1872.* In June, 1871, Marsh had previously described a species, *Hyopsodus gracilis*,† which

* Proc. Acad. Nat. Sci. Phila., 1872, p. 20 (published April 16).

† This Journal, vol. ii, 1871, p. 42.

Leidy, at the time he proposed the genus *Microsyops*, thought to be identical with the specimens he had in hand, and adopted Marsh's specific name *gracilis*. Marsh, however, in the same paper in which he described *Hyopsodus gracilis*, had proposed another species, *Limnotherium elegans*. From an examination of Marsh's types, Leidy afterward concluded that it was to *L. elegans* that his specimens were to be referred, and that *Hyopsodus gracilis* was a different species. His exact words are:* "The specific name of *M. gracilis* was originally given under the impression that the remains referred by Professor Marsh to *Hyopsodus gracilis* pertained to the same [species of] animal. A specimen exhibited to the writer by Professor Marsh would indicate that *M. gracilis* is the same as the animal named by him *Limnotherium elegans*. As *Microsyops* is generically distinct from *Limnotherium* as characterized from the typical species, *L. tyrannus*, the specific name of the former would be *Microsyops elegans*."

A careful examination of the types confirms Leidy's conclusions as given above, and establishes the further important fact that *Hyopsodus gracilis* of Marsh is not only distinct specifically, but represents an apparently undescribed genus of the Microsyopsidæ. The oldest members of this group come from the second stage of the Lower Eocene, or Torrejon beds, of New Mexico. The first species of this group found was described by Cope as *Mixodectes*.† Quite recently Osborn has added a second genus *Olbodotes*.‡ The chief characters of *Mixodectes*, which is known almost exclusively from lower jaws, are the following: There are eight teeth in the jaw, of which three are molars, three are premolars, one is a canine, and one an incisor; the last premolar is much simpler than the molars in structure; the two incisors, representing the central pair according to Osborn, are moderately enlarged.

Olbodotes has a full incisor dentition in the lower jaw, with a tendency to enlargement of the central pair. The premolars are reduced to two and the fourth premolar is simpler than in *Mixodectes*. It is therefore the most primitive species of this group thus far known, if correctly referred to this series.

From the succeeding Wasatch, Cope has described another genus under the name of *Cynodontomys*. This species, while very much like the Torrejon *Mixodectes*, differs from it in having lost either the canine or the second premolar and in the greater enlargement of the incisors.

In the Wind River, we have the first appearance of the genus *Microsyops*, which differs from *Cynodontomys* in the

* Extinct Vertebrate Fauna of the West, 1873, p. 84.

† Amer. Philos. Soc., 1882–1883, p. 550.

‡ American Eocene Primates, etc., Bull. Amer. Mus. Nat. Hist., 1902, p. 206.

more complex and perfectly molariform character of the fourth premolar. In the Bridger, from which the type of the family was derived, there are at least four well-marked species now known. The characters of the genus, as understood almost exclusively from the dentition, are as follows: There is but a single pair of incisors in the lower jaw and presumably a like number in the upper jaw; the enamel is not limited to the anterior face of the tooth, as in the Rodentia, but completely invests the crown, and the teeth are not of continuous growth; a small canine and two premolars are present, or no canine and three premolars, according to the way in which we interpret the first small tooth behind the enlarged incisor to be a premolar or canine; except, perhaps, in one species, the fourth premolar above and below is completely molariform; the superior molars are tritubercular in structure, with a faint beginning of a fourth cusp and a slightly developed mesostyle, which becomes stronger in the later species; the two rami of the lower jaws are not coössified.

I know of no remains of other parts of the skeleton that with certainty can be referred to any species of the genus. I have seen, however, some skeletal fragments which I strongly suspect belong to a species of this genus, but I lack the evidence to make the necessary connections.

Microsyops elegans Marsh.

Limnotherium elegans Marsh, this Journal, January, 1871, p. 12; *Microsyops gracilis* (in part) Leidy, Proc. Acad. Nat. Sci. Phila., 1872, p. 20; *Mesacodon speciosus* Marsh, this Journal, September, 1872, p. 205; *Palæacodon verus* Leidy, Proc. Acad. Nat. Sci. Phila., 1872, p. 20; *Microsyops elegans* Cope, Tertiary Vertebrata, 1883, p. 217; *Microsyops gracilis* Osborn, American Eocene Primates, Bull. Amer. Mus. Nat. Hist., 1902, p. 210.

Description of the Type.—The type of this genus and species consists of a fragment of a left mandibular ramus bearing the first and second molars, together with the fourth premolar, and the roots of the last molar. The anterior and posterior parts of the jaw are not preserved, so that it is impossible to determine the full dentition. The molar crowns may be described as consisting of an anterior, tricuspidate, elevated portion, usually termed the trigon, and a posterior, wider, less elevated part, or heel. The three cusps of the trigon are conical, and are placed in the form of a more or less perfect equilateral triangle, with the apex directed forward. Of these, the anterior is much the smallest of the three, the two posterior cusps being subequal in size and standing nearly opposite each other. The heel is considerably wider than the anterior, or trigonal, part of the crown and bears three distinct cusps enclosing a basin. Of these, one is external, one internal, and one posterior. The external cusp is the largest and

has a V-shaped pattern. One arm of the V extends forward and inward to join the base of the trigon and the other inward and backward to the posterior cusp. The internal cusp is relatively small and conical, and situated directly opposite the large external one. In front of this, between it and the internal cusp of the trigon, is a deep notch through which the valley opens internally. The posterior cusp of the heel is small and indistinct; it is situated upon the posterior rim of the central valley, more to the inner than to the outer side; it is connected with the outer V-shaped cusp by a low ridge, and is separated from the inner cusp by a notch. The crown of the fourth premolar is nearly like that of the true molars, the only noticeable difference in its structure being the absence of the anterior cusp of the trigon, together with the smaller size and more posterior position of the interior trigonal cusp. The chief characteristics of these teeth are seen in the broad heel as compared with the trigon, as well as the slight elevation and distinctness of the cusps of the latter.

Description of the Type of Mesacodon speciosus.—The specimen upon which this genus and species were founded

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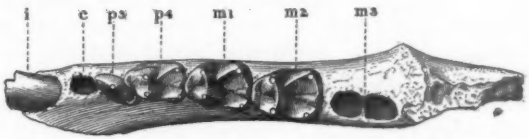

FIGURE 110.—Lower jaw of *Microsyops elegans* Marsh (type of *Mesacodon speciosus* Marsh); viewed from above; two and one-half times natural size.

consists of a well-preserved lower jaw, figure 110, of the right side, lacking the condylar, coronoid, and angular portions. The last molar is missing, as well as the canine or second premolar and the crown of the large incisor. After careful comparison with *Microsyops elegans*, I can not discover any difference between the two. The teeth are very nearly of the same size and, as far as ascertainable, the crowns of the molars and premolars are constituted in exactly the same way. I do not hesitate, therefore, to refer them to the same genus and species.

The additional information furnished by this specimen permits an accurate determination of the entire dentition of the lower jaw. The enlarged incisor is implanted by a distinct root and was not, therefore, of persistent growth; its position is procumbent, being directed much forward and a little upward. Most of the crown is broken away, but enough remains to show that the enamel was not limited to the anterior face of the tooth, as in *Cheiromys* and the Rodentia, but invested

it posteriorly as well as in front. The canine or second premolar follows without diastema, and judging from the size of its alveolus was relatively large. An indistinct ridge upon the inner side of the socket indicates that the root was grooved in this situation, a fact which is against its interpretation as a canine and in favor of its being a premolar. The third premolar had not been fully erupted at the time of death, and is only partly protruded from the jaw; it is implanted by two roots somewhat diagonally to the long axis of the ramus and has a pointed crown, with a small, though distinct, heel. The fourth premolar is identical in structure with that of the type of *M. elegans* already described, as are also the molars. The last molar is not preserved in either specimen. The ramus is deepest in front at the posterior border of the symphysis, narrowing considerably behind. The tooth line does not pass behind the coronoid to such an extent as in *Cheiromys* and the Rodentia. The anterior border of the masseteric fossa is prominent and, as in both *Cheiromys* and the Rodentia, toward its upper posterior portion forms the root of the coronoid, which therefore has a position much external to the tooth line. The opening of the inferior dental canal lies considerably below the level of the tooth crowns—a character in which it agrees with *Cheiromys* and differs from both the modern squirrels and *Paramys*. It may be further noted that the symphysis is roughened, but not coössified with the opposite ramus.

Description of other Material.—There are in the Marsh collection six other specimens of more or less complete lower jaws, which I refer to this species. Among these specimens there are several examples of a last molar. This tooth very closely resembles the other molars in structure, differing only in the elongation of the heel by reason of the greater size and prominence of its posterior cusps. In no case do any of the upper teeth accompany these lower jaws, but in another species to be described later, there are upper and lower teeth in association, so that the form of the upper molars is known with certainty. In my own collection there is a well-preserved upper jaw of a small form of *Microsyops*, bearing all the molars and the last premolar, which accord so well in size with what the upper teeth of *M. elegans* should be, that I have no hesitancy in attributing it to that species. I obtained this proportional size by measurement of the teeth of many living species of lemurs, as well as of those of the one known *Microsyops* above referred to.

There should be also mentioned here, the species described by Leidy under the name *Palæacodon verus*, from a superior molar. According to Leidy's figure, this tooth, figure 111, is identical with the upper teeth which I refer to *Microsyops elegans*, and it therefore becomes a synonym of that species—

a conclusion which has been already reached by Osborn. The more important features of the upper teeth of this species may be stated as follows: There are three molars, of which the first and second are subequal, with the third smaller; the crown has three main cusps and a faint indication of the fourth; the two outer cusps are more or less crescentic in structure; there is a small though well-marked mesostyle; both intermediates are present in the first and second molars, but the posterior is absent in the last; the fourth premolar is molariform, but lacks any trace of the posterior intermediate. I give herewith a reconstruction in outline of the dentition, figure 112, as derived from several specimens.

111

112

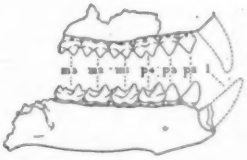

FIGURE 111.—Upper molar of *Microsyops elegans* Marsh (type of *Palæacodon verus* Leidy); crown view; twice natural size. (After Leidy.)

FIGURE 112.—Upper and lower jaws of *Microsyops elegans* Marsh; side view; natural size; composed from several individuals.

The measurements of the type of *Microsyops elegans* are as follows:

From base of posterior root of last molar to anterior extremity of crown of fourth premolar	16·0mm
From base of posterior root of last molar to anterior extremity of crown of first molar	11·0
Length of fourth premolar and first and second molars	11·0
Length of first and second molars	7·5

The measurements of the type of *Mesacodon speciosus* are:

Length from posterior root of last molar to base of incisor	20·0mm
From base of incisor to posterior extremity of fourth premolar	7·5
Depth of jaw at posterior border of symphysis	8·0
Depth of jaw at last molar	7·0

Measurements of the last lower molar and upper teeth of other specimens:

Length of upper molars	10·5mm
Length of upper molars and fourth premolar	14·5
Length of last lower molar	5·0
Length of second and third lower molars	8·5

The type specimen was found by Professor Marsh, at Grizzly Buttes, Bridger Basin, Wyoming. The type of *Mesacodon speciosus* was also found by Professor Marsh at the same place. Other specimens are recorded from this locality; also from Dry Creek, and from Millersville. The single specimen which I obtained is from the same horizon as that in which the type was found.

Microsyops gracilis Leidy.

Microsyops gracilis Leidy, Proc. Acad. Nat. Sci. Phila., April 16, 1872, p. 20; *Bathrodon typus* Marsh, this Journal, August, 1872, p. 19, Separata; *Microsyops typus* Osborn, Bull. Amer. Mus. Nat. Hist., 1902, p. 212.

As already noted, Leidy, in his final description of *M. gracilis*, believed it to be the same as *M. elegans*. This is undoubtedly true of the first specimen mentioned, but a second lower jaw was associated with the latter, with the expression of some doubt as to its specific identity. There are in the Marsh collection four specimens, exclusive of the type of *Bathrodon typus*, figure 113, consisting of the upper and lower jaws of a form which agrees in every way with the figures and descriptions given by Leidy of his second specimen. These are supplemented by three more examples of upper teeth obtained by myself in the type locality last summer. The additional material enables me to determine that this series of specimens is not only larger than the typical *M. elegans*, but

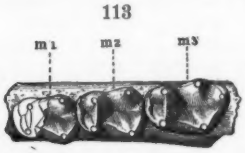

FIGURE 113.—Lower jaw of *Microsyops gracilis* Leidy (type of *Bathrodon typus* Marsh); viewed from above; two and one-half times natural size.
FIGURE 114.—Upper jaw of *Microsyops gracilis* Leidy; crown view; twice natural size.

presents other constant differences which I think impossible to account for on the basis of differences in age or sex. In no case are the upper teeth, figure 114, associated with those of the lower jaw, but as in the preceding species, the size and character of the two correspond so closely that there can be virtually no doubt of their relations. The more important distinctive characters are the following: The teeth are slightly larger than those of *M. elegans*, and the jaw is appreciably heavier and deeper; the last upper molar has a distinct mesostyle and a posterior intermediate cusp, both of which are absent in the same tooth of *M. elegans;* the fourth superior premolar has a mesostyle and the posterior intermediate dis-

tinct; the external cusps of the superior molars are apparently less flattened and crescentic than those of *M. elegans.*

In one specimen of an upper jaw, the second and third premolars are preserved, although the tooth which I take to be the second is not in place. The third is implanted by three roots, two of which are external and one internal. The crown is composed of a single large external and a smaller internal, or lingual, cusp. The second is a two-rooted tooth, much smaller than the preceding; its crown is a simple, transversely flattened cone, with a slight indication of a heel, and is very much like the corresponding tooth in many of the modern lemurs. No other parts of the skeleton are known, but I here call attention to an unassociated calcaneum, figure 115, which is not only Primate, apparently, but is about the right size for this or the preceding species and may possibly pertain to one of them. The Primate characters of the bone are seen in the short and incurved tuber, as well as in the arrangement of the facets, which are much like those in *Lemur catta.* The chief peculiarity, however, is in the elongation of the part below the astragalar facet, recalling at once the elongated calcaneum of some of the modern Madagascar species. I mention this matter for the reason that there is no other known Primate in the Bridger to which, as regards size, it could pertain. If this supposition is sustained, these animals are certainly Primates.

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FIGURE 115. — Calcaneum of *Microsyops (?);* dorsal view; twice natural size. *af,* astragalar facet; *st, sustentaculum tali.*

The measurements of the type of *Bathrodon typus* are as follows:

Length of second and third molars	8·25^{mm}

Measurements of other specimens:

From base of last molar to base of incisor	22·00^{mm}
Length of first and second molars	9·00
Length of fourth premolar and first and second molars	12·50
Depth of jaw at posterior border of symphysis	9·00
Depth of jaw at anterior border of third molar	10·00
Length of upper molars	11·00
Length of upper molars and fourth premolar	15·00
Length of third and fourth premolars and molars	18·00

The type of *Bathrodon typus* was found by Mr. F. Meade, Jr., at Grizzly Buttes; other specimens were obtained at Church Buttes and Millersville. I secured specimens on Cottonwood Creek and at Church Buttes. The calcaneum was found on Dry Creek.

Microsyops annectens Marsh.

Bathrodon annectens Marsh, this Journal, vol. iv, August, 1872, p. 19, Separata; *Microsyops annectens* Osborn, Bull. Amer. Mus. Nat. Hist., June, 1902, p. 213.

The type of this species, figure 116, consists of a fragment of a lower jaw of the left side, bearing the last molar. The only character by means of which it can be distinguished from the two preceding species, at least as far as the type is concerned, is that of size. This distinction, however, is so pronounced that the validity of the species can not be questioned.

116

FIGURE 116. — Last lower molar of *Microsyops annectens* Marsh (type of *Bathrodon annectens* Marsh); crown view; two and one-half times natural size.

The crown of the last molar has identically the same structure as that of *M. elegans* and of *M. gracilis*. The trigon is slightly elevated above the heel and the anterior cusp is not very distinct. The heel displays its characteristic breadth, with the large external lunate cusp and the smaller external and posterior cusps. The posterior cusp is not situated at the center of the posterior border, but very much to the inner side, in a position almost behind the internal—an arrangement which gives an imperfect quadrilateral outline to the heel. This is highly characteristic of the genus *Microsyops*, and insures its recognition at sight.

In the present collection, there are four other specimens represented by lower jaws alone, which give the lower dentition in its entirety. The form, proportions, and relations of the other teeth are very like those in the two species already described.

The measurements of the type are as follows:

Length of last molar	5·8 mm
Depth of the jaw at anterior margin of third molar	11·0

Measurements of other specimens:

Length of molar series	16·0 mm
Length of second and third molars	10·0
Length of molars and premolars to base of incisors	30·0

The type specimen was found near Henry's Fork, by Mr. F. Meade, Jr., of the Yale party, in September, 1871. Additional specimens from the same locality were obtained by Mr. Harger and others.

Microsyops Schlosseri sp. nov.

This species is founded upon a fragment of a left mandibular ramus, figure 117, bearing the second and third molars, together with two fragments of the upper jaw containing the first and second molars in one, and the second molar in the other. There is also an anterior portion of a jaw, bearing a part of the incisor and the premolars much worn, which I likewise refer to this form.

The chief difference between this species and *M. annectens* is one of size. It exceeds *M. annectens* to about the extent that the latter exceeds *M. gracilis*. Another feature of importance is seen in the wrinkled surface of the enamel, especially in the valley of the heel, where it is quite rugose. The anterior cusp of the trigon is small, though distinct, in the crown of the first molar, but consists of little more than a thickened cingulum in the second. The internal cusp of the trigon is broken, but apparently had about the same degree of elevation as is usual in the other species. The jaw is notably heavier than that of *M. annectens*.

117

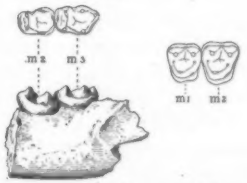

FIGURE 117.—Upper and lower molars of *Microsyops Schlosseri* Wortman; side and crown views; one and one-half times natural size. (Type.)

Associated with the type lower jaw is a second upper molar which seems to be too much worn to belong to the same individual. The specimen, however, was collected by Professor Marsh himself, and knowing his great care in such matters, there must have been in the manner of their occurrence very good reason for putting the two together. A second isolated fragment of an upper jaw includes the first and second molars. The chief characters of these teeth are as follows: The outer cusps are moderately flattened externally; the mesostyle is distinct, though small; the intermediates are as in the other species; the postero-internal cusp is represented by little more than a cingulum in the second, but is more distinct in the first; the enamel is rugose.

The following are the chief measurements of the type and of the upper molars referred to this species:

Length of second and third lower molars	12·0 mm
Length of last lower molar	6·5
Depth of jaw at anterior border of third molar	10·5
Antero-posterior diameter of first and second upper molars	10·5
Transverse diameter of second upper molar	6·0

The type specimen was found by Professor Marsh, at Henry's Fork of Green River, August 9, 1873. The other specimens were obtained at the same locality.

In addition to the species herein described, there are probably at least two others indicated by fragmentary specimens. One of these consists of an upper molar tooth of a small species about equal in size to *M. elegans*. It comes from the upper horizon of Henry's Fork, and differs from the upper teeth which I have attributed to *M. elegans* in the absence of the mesostyle, absence of intermediates, and the greater prominence of the postero-internal cusp. It apparently belongs to *Microsyops*, but I refrain from proposing a specific name for so fragmentary a specimen.

In like manner, there is a fragment of an upper jaw containing two molars, from the lower horizon. The structure of these molars differs from all other species of *Microsyops* from the Bridger beds in the more distinctly conical shape of the external cusps, as well as in the prominence of the intermediates. I suspect that the form may be the same as one of the Wind River species in which the upper teeth are entirely unknown.

Smilodectes gen. nov.

This genus is founded upon the specimen originally described by Professor Marsh under the name of *Hyopsodus gracilis*. Osborn in his synonymy refers it to *Sarcolemur*, but the structure of the teeth distinctly forbids its reference to either of these genera. In certain respects the dentition, as far as known, resembles that of *Microsyops* more than that of any other genus, but in others it exhibits distinct relationship to that of *Notharctus* and *Limnotherium*. The number of teeth in the lower jaw is eight, as against seven in *Microsyops*, of which the most anterior is an enlarged incisor. Just as in *Microsyops*, the succeeding tooth may be rated either as a canine or an incisor; if a canine, there are then three premolars and if a premolar, there are four. The fourth premolar is not molariform. The single enlarged incisor distinguishes the genus from *Notharctus* and *Limnotherium*, and the more complex fourth premolar from *Mixodectes*.

Smilodectes gracilis Marsh.

Hyopsodus gracilis Marsh, this Journal, July, 1871, p. 42.

The type of this species and genus consists of the anterior part of a left mandibular ramus, figure 118, containing the fourth premolar, first molar, and a portion of the third pre-

molar. Parts of the alveoli for all the remaining teeth in front are also recognizable, so that the number of the teeth can be accurately determined. With this I associate three other specimens, in two of which the last molar is well preserved.

The jaw has about the same depth as that of the larger species of *Microsyops*, which it otherwise resembles in its general form. The symphysis is deep and rugose, projecting somewhat below the level of the lower border of the ramus, but exhibits no traces of coösification. The alveolus of the enlarged incisor lies close to the symphysis, and unlike that of *Microsyops* indicates an almost vertical position for this tooth. Immediately behind the incisive alveolus is a medium-sized socket for the first premolar or canine. Behind this comes a two-rooted tooth, with the larger of the roots posterior. The third premolar is likewise two-rooted. A portion of the crown denotes that there was a slight indication of a heel. The rest of the crown is broken away. The fourth premolar is in about the same stage of evolution as that of *Limnotherium* or *Notharctus*. The internal cusp, however, is smaller, but the heel is broader and provided with two cusps instead of one. The first molar also closely resembles that of *Limnotherium tyrannus*, lacking the great transverse breadth of the posterior part of the crown seen in *Microsyops*. The arrangement of the cusps is very similar to that seen in *Limnotherium*.

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FIGURE 118. — Anterior portion of lower jaw (type of *Hyopsodus gracilis* Marsh) and last lower molar of *Smilodectes gracilis* Marsh; side view of jaw, and crown views of teeth; one and one-half times natural size.

I also place in this species three specimens in which the last lower molar is preserved, but which do not show the number of teeth. The association may be therefore incorrect. In one specimen, part of an upper molar is preserved which exhibits a structure like that of *Microsyops*, and not like that of *Limnotherium*. The last lower molar, on the other hand, resembles the same tooth in *Limnotherium* more than that of *Microsyops*, from all of which, in connection with the characters of the type, I conclude that the specimens must be referred to the species under consideration.

The last molar differs from that of *Microsyops* in the central position of the posterior cusps. In *Microsyops*, as we have already seen, this cusp stands almost directly behind the internal one. In this respect the tooth resembles the last molar of *Limnotherium*, but the cusp is not so large and is more distinct from the posterior rim of the heel. Again this molar differs from that of *Limnotherium* in having a distinct internal

cusp of the heel, as in *Microsyops*. Associated with one of the specimens containing the last lower molar is a portion of an upper molar. Enough is preserved to show that there were three main cusps, together with a rudimentary fourth, very much as in *Microsyops*.

The type specimen was found by Professor Marsh, at Grizzly Buttes, Bridger Basin, on September 5, 1870; other specimens were obtained at the same locality.

The Relationship of the Microsyopsidæ.

There is as yet no absolutely conclusive evidence by means of which the position of this group can be determined with certainty. The species had always been considered, without good reason, to belong to the Primates, until Matthew, from an associated astragalus of *Mixodectes pungens*, put forth the view that these forms are rodents. Osborn following Matthew, placed them in a primitive suborder of the Rodentia, which he called Proglires. He says:* "*Relationship to the Rodentia* is now found to be indicated by: (1) progressive elongation of median incisor; (2) disappearance of lateral incisor; (3) reduction of canines; (4) disappearance of the anterior premolars and reduction of third premolar; (5) transformation of fourth premolar into molar forms, thus foreshadowing a homodont molar-premolar series; (6) width and extension of talonid (as in Eocene *Paramys*); (7) rodent form of astragalus. *Against* the *Rodent relationship* are: (1) Persistence of the canine; (2) absence of diastema; (3) absence of any evidence (except the levelling of the premolars) of adaptation for antero-posterior or orthal motion of the jaw."

If the astragalus which Matthew associates with the lower jaw of *Mixodectes* really pertains to the same animal, there is then strong presumptive proof that this species, at least, is not a Primate. From long personal experience in collecting in the Torrejon beds, however, I have found that only too frequently the fossils are washed out of their original matrix and badly mixed. Without a full knowledge of the circumstances under which these particular specimens occurred, and in the absence of reasonably conclusive evidence which would tend to preclude the possibility of a mixture, I should not feel inclined to attach any very great weight to this association. At all events, I should wish some stronger evidence upon which to rest so important a generalization. As for Osborn's alleged additional evidence of relationship to the Rodentia, attention may be called to the fact that he seems to have overlooked *Cheiromys* and left it out of account entirely. With the

* American Eocene Primates, etc., Bull. Amer. Mus. Nat. Hist., 1902, p. 204.

exception of the character of the astragalus, which, as we have just seen, is open to question, all the characters cited, save one—the molariform fourth premolar—are evidence of relationship with, and apply equally to *Cheiromys* as well as to the Rodentia. The molariform fourth premolar is not an especially rodent character. It occurs among the Lemuroidea in *Hapalemur griseus*, *Otogale Monteiri*, *Galago Alleni*, and *Hemigalago Demidoffi*. In like manner, the evidence against rodent relationship, as given by Osborn, can be quite as well considered to be evidence against relationship to *Cheiromys*, for Owen has long since conclusively demonstrated that this species is a Primate, with a highly modified rodent-like dentition. Altogether, I fail to see wherein Osborn has given any reasons, beyond those already well known, for regarding the Microsyopsidæ as members of the Rodentia. On the contrary, to my mind, there is fairly conclusive proof that these animals are not rodents. I shall now proceed to a statement of this evidence.

In Part I of the present series of papers (p. 96, Separata), I have presented my views at some length upon the theory of "Cusp Migration," as originally propounded by Osborn.* I have likewise dissented from the use of the terminology of the mammalian molar cusps proposed by him, on the ground that their homologies were incorrectly determined and the names applied inappropriate and misleading. I have further expressed the opinion that, as far as any nomenclature is applicable to these cusps, which would convey any information of their homological relationship, that proposed by Scott is preferable because based upon ascertained and undisputed facts in the history of the premolar series. By far the most important principle embodied in Scott's determination of the order of appearance and homological position of the cusps of the premolars, although never expressed nor stated by him, is that by means of which we are provided with the key to a proper interpretation of the molar cusps and the determination of their history. All theoretical considerations, as well as all the evidence obtainable, point with such directness and definite precision to the conclusion that the molars and molariform premolars have passed through identically the same changes and have been subjected to precisely the same influences, that it may be accepted as one of the basic and fundamental truths of dental morphology. Credence in any other view would be equivalent to believing that the corresponding teeth on the opposite sides of the mouth have had different histories. This principle or law has not as yet been ocularly demonstrated, for the reason that no Eutherian mammals older than those from

* Jour. Acad. Nat. Sci. Phila., 1886, p. 242.

the Tertiary are known. In the earliest Eocene, the molars, with a few notable exceptions, had already assumed such a degree of complexity as practically to obliterate all traces of the order of appearance and manner of development of the cusps. When, however, the ancestors of the Puerco fauna are found, and the more primitive stages of their tooth development obtained, I look forward with the utmost confidence to the production of all the evidence necessary to a complete and final demonstration of the truth of this hypothesis.

While this principle, enunciated by Scott, may be made to include any given group of mammals, and the history of their molar cusps thus determined, yet at the same time I feel well assured that no general law can be framed nor can any terminology be devised which will be applicable to all the Mammalia, unless it is confined strictly to the position of the cusps, without any reference whatever to their homologies. The reason for this difficulty is, that different groups of mammals have adopted different plans for increasing the complexity of their molars. In many divisions, the order of appearance and position of the cusps, as outlined by Scott, undoubtedly obtains; but in others, as I shall presently show, it has been different.

Taking as a starting point a transversely flattened conical crown, a complicating premolar of the inferior series, in a large number of groups of the Mammalia, passes through the following stages: (1) The posterior edge or slope of the crown elongates and develops a second or posterior root; (2) this slope of the crown becomes thickened transversely, and flattened from before backward, so as to present a triangular area with the apex at the summit; (3) this area looks upward and backward, and is bounded by a descending ridge on each side; (4) a thickened ledge is formed at its base, foreshadowing the heel; (5) on the *inner* descending ridge, bordering the posterior triangular area, appears a new cusp, small at first, which is *posterior and internal to the main cusp;* (6) concomitantly, the heel broadens and its posterior edges grow up in such a way as to form a basin; (7) at the same time a cusp may or may not be developed, at the anterior slope of the crown; (8) the heel develops two cusps, one of which is external and one internal in position.

Thus, it will be seen that all the elements necessary to the formation either of the quadritubercular or of the so-called tuberculo-sectorial crown are present, and further growth of the new elements is all that is required to effect a complete molariform transformation. That the evolution and development of certain premolars has taken place in this manner, is supported by a great abundance of evidence from many well-known phyla whose history has been determined with consid-

erable exactness. In connection with teeth having this developmental history, one important point to remember is, that the antero-internal cusp, or the one which originates upon the inner ridge of the posterior triangular area, is always slightly posterior to the antero-external or main cusp. And it is also of the *utmost importance* to recall that the apex of the original single-pointed premolar corresponds to, and is homologous with, the antero-external cusp. This has been determined as true of the Ungulata, Carnivora, Insectivora, Primates, and probably of other orders.

In the case of the Rodentia, however, it is different. If a perfectly unworn, lower fourth premolar of a member of the Sciuromorph division is examined, figure 119, it will be seen that the new cusp, instead of originating upon the internal, is an outgrowth of the *external*, descending ridge bordering the posterior triangular area. It thus happens that the cusp which corresponds to, and is homologous with, the apex of the original single-pointed premolar *is the antero-internal and not the antero-external cusp, as in the orders just referred to.*

a 119 *b*

FIGURE 119.—Fourth lower premolar of a species of *Paramys;* outside (*a*) and crown (*b*) views; three times natural size.

Further proof of this is found in the fact that the antero-internal cusp has a position in advance of that of the antero-external, which should be the case if the new element had arisen upon the external instead of upon the internal ridge. The ancestral type of the Sciumorphs is represented by the genus *Paramys* of the Eocene, figure 119, and in this group the manner of origin of the premolar cusps is clearly shown. Distinct traces of this succession are still visible in the squirrels and spermophiles of the present day. The genus *Mysops* of the Bridger beds (*Eomys* of the European Eocene), while closely allied to *Paramys*, without much doubt represents the beginning of the Myomorph division of the Rodentia, and it is interesting to note that this same plan of origin of the cusps of the lower premolars is true of this group as well. No sufficiently primitive stages of the teeth of either the Histricomorphs or the Lagomorphs have to my knowledge as yet been found, which would enable one to say with absolute certainty whether or not the complication of their teeth has

followed this plan or some other,* but I think there can be little doubt that it is a rule of very general application and a fundamental character of the entire order.

From this it follows that no names can be given to these cusps unless we wish merely to indicate their position. Professor Osborn, in reply to my strictures upon his cusp nomenclature, says that "although wrong the names should still stand." His terminology was proposed to supersede the old names then in vogue, which attempted nothing more than to indicate position. This proposal was elaborately made, and its adoption has been strenuously insisted upon, on the ground that the homologies of the cusps had been determined and that Osborn's system thus expressed something more than the mere fact of position. The names themselves carry with them the significance of this alleged homology, which, according to the oft-repeated and many-times-published statements of its author, constitutes one of its chief merits. In view of the facts above set forth, however, I am more firmly than ever of the opinion, that all such attempts are foredoomed to failure, and I believe they should be abandoned as utterly useless and confusing; that of Professor Osborn, being doubly erroneous, is therefore the most open to objection in this regard.

The Microsyopsidæ, as we have already seen, follow the Primates in the plan of addition of the cusps to the premolars and presumably to the molars also, which, to my mind, effectually disproves Osborn's suggestion that they are members of the Rodentia. If further evidence is required, we have only to refer to the great dissimilarity in the structure of the molars in the two groups. In no living rodent does the molar pattern approach that of *Microsyops*, except, perhaps, in the squirrels and their extinct forerunner, the Eocene *Paramys*, but even here the differences can be readily detected. Among the Lemuroidea, on the other hand, the great similarity in the constitution of the molar crowns to those of the Microsyopsidæ is apparent at a glance. Add to this, the completely transitional molar pattern afforded by *Smilodectes*, together with the strong evidence that the contemporary *Metachiromys* was a Primate, and the proof of their relationship is all but demonstrated.

* *Sciuravus* Marsh, of the Bridger, which in many respects is closely related to *Paramys*, furnishes the beginning of a modification leading directly into such types of molar crown as those seen in *Steneofiber*, *Palæocastor*, and *Castor*. In like manner, *Mysops* and *Sciuravus* afford the stem types from which both the Histricomorphs and Myomorphs were in all probability derived. This subject will be more fully treated in a subsequent part of the present work.

[To be continued.]

ART. XXXVI. — *Triadenum Virginicum* (L.) Rafin. *A morphological and anatomical study;* by THEO. HOLM. (With figures in the text.)

THERE are said to be at least thirty generic synonyms of *Hypericum*, of which Spach is the author of nineteen; *Hypericum* L. is, however, the only one recognized by Bentham and Hooker, while the other genera are treated merely as sections of two large groups: in accordance with the presence or absence of hypogynous glands in the flower. The suppression of these proposed genera may in some instances seem justified, since not a few of the writers who have dealt with the segregation of genera, and especially of small ones, have perhaps gone too far in their discrimination, or they have not always expressed their reason for making these segregations as clearly as might be desirable. But whatever the case be, a renewed study of several of these segregations may lead to their reëstablishment, especially after careful observations in the field, rather than by continued research in herbaria.

Moreover, in late years the anatomical method has rendered great assistance by the supplementing of characters derived from the internal structure. The actual value of such anatomical characters is, however, only to be perceived when the structure of most of the species of a given genus is known, and we believe that, for instance, the *Hypericaceæ* have been studied thoroughly from this point of view to enable us to draw certain distinctions between the genera.

In presenting a study of the genus *Triadenum*, it is the writer's intention to demonstrate the validity of one of the obscure genera of Rafinesque, which has, as it appears, been imperfectly known heretofore, and ignored by most authors, even by Bentham and Hooker. The history of the genus is very brief. Rafinesque removed Linnæus's *Hypericum Virginicum* from the genus and referred it to a new genus *Triadenum*, on account of the presence of three glands in the flower, alternating with the stamens. *Triadenum Virginicum* (L.) Rafin. is also known under the name *Elodes* or *Elodea Virginica*, but this genus, established by Adanson, does not include plants of habit or structure like that of *Triadenum*. Finally, *Hypericum Virginicum*, as described in the Synoptical Flora,* is our plant, and it so happens that we have not reached a single step farther in regard to the classification of this plant than at the time of Linnæus.

It is true that Rafinesque founded his genus *Triadenum* on no other characters than the floral glands and reddish flowers,

* For references consult the Bibliography appended to this paper.

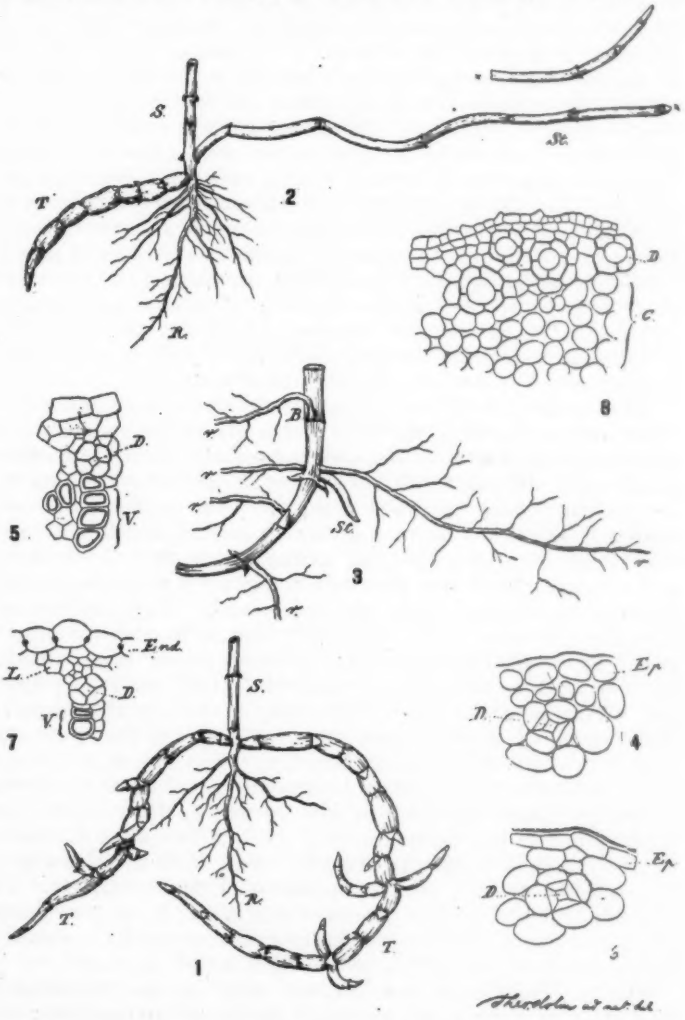
remarkable, however, in the genus *Hypericum*, but to a critical student it would appear as if there might be some good reason for suspecting additional, and perhaps more valid, characters to accompany those, already pointed out by Rafinesque; and from the writer's observations upon this plant in a living state through several seasons, *Triadenum* has proved to be quite an interesting plant and undoubtedly a good genus.

The flesh-colored flower attracted our attention when we saw the plant for the first time, growing in a swamp in company with *Rhexia*, *Asclepias*, *Eriocaulon* and others, and when we examined the parts underground, we found a rhizome, which was very different from that of other species of "*Hypericum*," as far as known. A continued study of the plant from seedling and of the subterranean organs in connection with an anatomical investigation of the vegetative organs compared with those of other members of *Hypericaceæ*, and quite especially of *Hypericum*, has convinced us that *Triadenum* possesses sufficient morphological and anatomical characters to entitle it to a genus. In presenting the results of our study, we will begin with some notes upon the morphology of the plant which have not been hitherto recorded.

In the seedling stage, *Triadenum Virginicum* does not differ from most of the species of *Hypericum* except in the very characteristic glaucous hue of the leaves. There is a primary root, a short hypocotyl and a pair of small cotyledons above ground. The seedling reaches the flowering stage commonly in the first summer, and ripens the seeds late in the fall, while the main axis dies off during the winter. Nevertheless the plant is perennial, for during the flowering period the basal stem-portion has commenced to ramify, and shows from one to two pair of horizontal branches, stolons, which are developed in the axils of the cotyledons and the subsequent pair of leaves. The former, those that arise from the axils of the cotyledons, are characteristic by their somewhat swollen and short internodes, and small, membranaceous, scale-like leaves; they ramify freely, but are rootless for several months (T in figures 1 and 2); their color is crimson or yellowish brown. The other stolons (St. in figure 2), which develop further up the stem, have longer internodes, and are not swollen, and as a rule they do not ramify. When we examine the plant in the succeeding early summer, the main axis, including the main root (R in figs. 1 and 2) has died off altogether, while several vegetative or already flowering shoots have developed from the stolons; and when these aërial shoots finally die off during the fall, the remaining part of the tuberous stolon is able to continue its ramification for at least another year.

Triadenum Virginicum thus possesses an underground

rhizome of more or less tuberous stolons with scale-like leaves, which, to our knowledge, is not met with among the species of



Hypericum proper. If, for instance, we examine the perennial *Hypericum maculatum* during the winter, we observe the presence of numerous green shoots above ground at the base of the withered flowering stem, and these shoots are also

developed from the axils of the lower stem-leaves, perhaps even from the cotyledons. But they are not subterranean; they bear only green leaves and have no swollen internodes, and a like manner of propagation is met with in other species, for instance *H. perforatum* and *H. tetrapterum*. The rhizome of *Triadenum* is especially characteristic, by the fact that while the underground portion of the main axis stays alive for some time, it never shows the swelling of the internodes as do its lateral branches, at least those from the axils of the cotyledons. Tuberous rhizomes are common, as we remember, but they are mostly of two kinds: either is the main axis very slender and develops equally slender, horizontally-creeping stolons of which the outermost internodes become swollen so as to form a tuber, "tuberiferous stolons," or the main axis is already at the seedling stage visibly swollen, the swelling being moreover observable in all the subsequent internodes, that stay underground, as we remember from *Sanguinaria*, *Podophyllum* and many others; such rhizomes are called "tuberous."

Now in regard to the root-system, *Triadenum* possesses a main root, as shown in figures 1 and 2 (R.), which persists for about two seasons, when the stolons break off from the mother plant and develop adventitious roots at the nodes (*r* in figure 3), or more correctly just above these. The position of these adventitious roots is quite singular since they break out in a very short distance above the axillary buds, one above each, and when the buds stay dormant, the roots appear as if they were axillary; these roots are endogenous. This position of adventitious roots is not frequently met with, and we might recall some of the earlier observations upon this subject. Most frequently secondary roots develop at the nodes of stems, and when the leaves are opposite (and the stem quadrangular?) there may be observed four such roots at each node, one on each side of the leaf-base, or there may be several, as in a number of *Gramineæ*, *Juncaceæ*, *Ranunculaceæ*, *Umbelliferæ*, etc.

Irmisch found from one to four secondary roots above the axillary bud in certain species of *Pyrola;* Professor Warming observed a similar position of such roots in *Hottonia*, *Dentaria*, *Cardamine*, *Sedum*, various species of *Campanula*, etc. In *Pyrola aphylla*, which we have described in a previously published paper, the adventitious roots do not break out exactly above the buds, but a little to the right or left of these.

But in *Triadenum* we observed only one root above each bud, two at each node, although the leaves are opposite; we must not forget, however, to state that the stem is cylindrical in this genus.

While thus the subterranean organs of *Triadenum* offer several points of interest, and by which the genus shows a

marked deviation from the genus *Hypericum*, the organs above ground are of no less importance. We need only refer to the floral structure, as already indicated by Rafinesque. But besides this the leaves show a character by which they may be readily distinguished from those of broad-leaved species of *Hypericum*, not including *Androsæmum*, which is evidently a distinct genus; this character consists in the venation: the veins in *Triadenum* being very prominent on the lower face of the blade, and the secondaries being more numerous, but shorter and proceeding from the midvein under an angle that is much broader than is observable in the leaves of *Hypericum*. In the latter the secondaries proceed, as a rule, from below the middle of the midvein, while in *Triadenum* they are noticeable almost to the apex of the blade. These are the points which we observed in the external structure of our plant, and which ought to be mentioned in the diagnosis, whether it be accepted as a genus or not.

The observation of these characters induced the writer to extend the study to the internal structure, and to compare this with what is known, so far, about the general anatomy of the order. Moreover, *Triadenum* has not hitherto been examined from this point of view, and, as will be seen in the following, it possesses certain structural peculiarities which, together with the morphological, seem to entitle it to generic rank. The anatomy of the vegetative organs is as follows:

The root.

On the almost capillary, lateral roots developed upon the main one, hairs occur in abundance; there is a narrow cortical parenchyma, which is quite solid, and of which the cells are arranged radially towards the thin-walled endodermis, in which the spots named after Caspary are plainly visible. The pericambium consists of two layers outside the leptome, but of only one outside the hadrome. The root is diarchic with, in all, four vessels in two groups separated from each other by a few strata of thin-walled conjunctive tissue, and alternating with two groups of leptome. Ducts of rhombic cross-section are developed in the pericambium, one outside each of the two groups of leptome. Roots that are slightly thicker show the same structure, but are triarchic. But if we examine one of the thicker, lateral roots, we notice the structure to be somewhat different; the cortex, consisting of seven layers, shows a tangential collapsing of the innermost five; the endodermis shows a number of radial divisions, while the pericambium exhibits the same structure as in the thinner roots, though with a larger number of ducts outside the broad groups of leptome; these ducts are, also, rhombic in transverse section and have

four secretory cells; the hadrome consists of many vessels with a few strata of thick-walled conjunctive tissue.

The secondary roots developed upon the rhizome are quite thick and show the same collapsing of the cortical parenchyma; the pericambium has commenced to divide itself tangentially with the large ducts still persisting, and, moreover, similar ducts are, also, observable in the leptome; a small cambium is developed and the hadrome occupies the greater portion of the central cylinder. In other words, these secondary roots show the structure of the perennial type. Van Tieghem, who studied the root of *Hypericum calycinum* (evidently "lateral roots"), observed two ducts in the pericambium, one on each side of the leptome, but none in the leptome itself.

The aërial stem.

This is glabrous and cylindrical with a thick-walled epidermis, which covers some five or six layers of cortical parenchyma with distinct intercellular spaces, but without lacunes; there is a thin-walled endodermis surrounding the leptome, cambium and hadrome, and the innermost part of the central cylinder is occupied by a pith, which soon becomes hollow. No stereome or hypoderm was observed. Two kinds of ducts occur in the stem; some with the four secretory cells very narrow (fig. 6), which traverse the cortex close to the epidermis, and of which there may be until twenty, and others with wide secretory cells (fig. 7) which are developed in the leptome and which are very numerous. In the uppermost portion of the stem, where the pith was unbroken, a single duct, rhombic in cross-section, was observed in the center. The occurrence and arrangement of the ducts in the stem seems very variable, and has been described by Van Tieghem in species of *Hypericum*, *Tridesmis*, *Haronga*, etc., but they do not seem to be frequent.

When present in the pith the ducts are said to occur to the number of four, evidently corresponding with the four angles of the stem; the single and central duct observed in the pith of *Triadenum* seems thus to correspond with the circular outline of the stem.

The rhizome.

The stolons, slender and tuberous alike, have several layers of cork underneath the epidermis; the cortex forms a broad, but very open, tissue, and there is an endodermis of the same structure as observed in the above-ground stem. The leptome and hadrome enclose a central pith of rather small cells. Ducts are quite numerous in the internodes and we counted about forty in the cortex near the periphery, which were round, not rhombic, in transverse section (D in figure 8); besides these

there were twelve others, of the same shape, in the leptome. No ducts were found in the pith. The structure of the tuberous rhizome of *Triadenum* is so different from that of *Hypericum calycinum*, that a comparison seems unnecessary; we might only state that Van Tieghem found four ducts in the pith, corresponding with the four rows of leaves.

The leaf.

The aërial leaves are glabrous and very glaucous; the structure is bifacial. Very characteristic is the marked difference in the lumen of the epidermal cells, when we compare the upper face with the lower, the cells of the upper being much the larger. Stomata occur only on the lower face; they are surrounded by three to four cells and are sunk below the epidermis; the cuticle is smooth.

The palisade tissue consists of but one layer and is quite solid, in contrast to the open pneumatic tissue. The midrib is prominent on the lower face, where it is supported by a collenchymatic tissue, but without any stereomatic layers. The translucid spots, so very characteristic of the order, are, also, noticeable in *Triadenum*, but the dark spots are entirely wanting. Ducts like those described in the stem occur, also, in the leaves and are of two kinds: Rhombic (in cross-section), with narrow secretory cells (D in fig. 4), were observed in the collenchyma and close to the epidermis; these, five in all, accompany the midrib to about the middle of the leaf-blade, but not any further. The other kind are, also, rhombic, but the lumen of the secretory cells is much wider; these, five in all, are located in the leptome (D in fig. 5) and may be followed throughout the length of the midrib.

So far as known, the stomata in the *Hypericaceæ* are only surrounded by two or three cells, thus *Triadenum* forms an exception; and the presence of ducts in the leaf seems to be exceedingly rare, and usually restricted to the petiole alone. The disposition of the ducts in the vegetative organs of *Triadenum* seems characteristic of the genus, when compared with the other *Hypericaceæ*, and four systems may be recognized:

(1) The medullary, only observed in the stem above ground; (2) those of the cortex in the stolons, the stem and the leaf-blade; (3) those of the pericambium of the root; (4) those of the leptome in the root, the stem, the stolons and the leaf.

There is, still, another species of *Triadenum* in this country, *T. petiolatum*, and we regret to say that we have been unable to secure fresh material of this for comparison. Judging from the structure of the flower and the venation of the leaves, it appears to belong to this genus, but, as is often the case, the parts underground are but seldom preserved in herbarium-specimens. We hope that future observers may study this species, and

make a comparison between the two. But whatever the result may be, Linnæus's *Hypericum Virginicum* can no longer be considered as a species of this genus, and even if Rafinesque did not give but a mere hint as to its probable validity as a genus, *Triadenum*, nevertheless, appears tenable and indeed quite distinct from *Hypericum* and the other "generic synonyms."

Brookland, D. C.

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EXPLANATION OF FIGURES, p. 371.

Triadenum Virginicum (L.) Raf.

FIGURE 1.—Rhizome of a specimen, collected in October; natural size. S = base of fruitbearing stem; T = two tuberous stolons, developed from the axils of the cotyledons; R = the primary root.

FIGURE 2.—Rhizome of another specimen, collected at the same time; natural size. St. = a slender stolon, developed from the axil of one of the lower stem-leaves; the other letters as above.

FIGURE 3.—Rhizome of a specimen, collected in June; natural size. This rhizome represents a tuberous stolon, of which the terminal bud has developed into an above-ground stem. B = an axillary bud, still dormant; St. = the beginning development of an axillary stolon. *r* = secondary roots, developed above the axillary buds.

FIGURE 4.—Transverse section of a leaf. Ep = epidermis of the lower face; D = a duct. ×320.

FIGURE 5.—Transverse section of a leaf; the duct (D) is here located in the leptome; V = vessels. ×320.

FIGURE 6.—Transverse section of stem. Ep. = epidermis. D = a duct, located in the cortex. ×320.

FIGURE 7.—Transverse section of stem. End = endodermis. D = a duct; L = leptome; V = vessels. ×320.

FIGURE 8.—Transverse section of a tuber. C = cortical parenchyma; D = duct, of which four are visible in this section. ×75.

Art. XXXVII.—*Ephemeral Lakes in Arid Regions;* by Charles R. Keyes.

The bolson plains—those broad mountain-locked basins which occupy so large a part of the high plateau regions of both Old and New Mexico—present certain geographic peculiarities that many writers have taken as evidence of their lacustrine origin. Their Spanish name signifies a purse. This they certainly are. From the immediate piedmont zone there is a gentle slope from all sides towards the middle. Drainageways there are none. And the central depression has no outlet. The reported remnants of old terraces on the mountain slopes, so far as personal examination has gone, all seem to be mistaken interpretations.

Since the flat-bottomed intermontane basins assumed their present attitude as slightly warped surfaces of an old destructional plain, they have been modified by fluviatile rather than lacustrine conditions. The old surface, formed on the beveled edges of Paleozoic and Mesozoic strata, has been covered by deposits which, though they are stratified gravels, sands and clays, must be now regarded as of subaërial origin.

The coarse materials covering the bolsons are readily seen to be composed of the same kinds of rocks that are found in the adjoining mountains. The arroyas in flood time carry out into the plain immense quantities of bowlders, gravel and finer materials. These produce great alluvial fans which become confluent and form marginal conglomerates of great thickness. For example, in the Sandoval bolson at the foot of the Ortiz mountains, the conglomerates are 150 or more feet in thickness. Shumard* reports their thickness in the Jornada del Muerto at 500 to 600 feet. Powell,† Dutton,‡ Hill,§ and others have described these bolson gravel deposits and consider them to have a subaërial genesis. This evidence is sufficient to clearly indicate that for the great part at least the later deposits of the bolsons cannot have ascribed to them a lacustrine origin.

There are some of the bolson plains in which limited deposits occur giving undoubted evidences of the existence of old lakes. The Sandoval bolson, south of Santa Fe, contains traces of a comparatively recent lake of considerable size. At the present time the remnants are found in a group as small salt ponds, the chief of which is Laguna del Perro.

There is a class of lakes which occur in connection with the bolsons which appear to have escaped the notice of writers on the arid regions. For want of a better title they are here called ephemeral lakes. They originate under abnormal though frequently recurring conditions.

* Trans. St. Louis Acad. Sci., i, p. 341, 1858.
† Geology of Unita Mts., p. 170, 1876.
‡ Geology High Plateaus, p. 219, 1880.
§ Occurrence of Artesian and Underground Waters, etc., p. 140, 1892.

On the Jornada del Muerto and many other similar basins there are slight depressions in the surface, which during the rainy season collect the storm waters in sufficient quantities to last several months. These ponds, which are frequently half a mile across, are welcomed by the stockmen.

Of similar character, but on a much grander scale, are certain ephemeral lakes which are known to have been formed at a comparatively recent date. From the local reports concerning some of these, there seems to be something of the mythical. There are, however, several instances, which are well authenticated, of the sudden formation of such lakes and their existence through a period of years.

One of these is located on the Mexican Central Railroad near the station called San José, about 75 miles south of El Paso in the state of Chihuahua, Mexico. This depression in the plain had been reported in the past to have contained water at times. The Rio Carmen, which runs west of Chihuahua and about 100 miles from San José, loses itself in the plain. Whenever there are excessive rains, which are said to occur at rare intervals along this stream, the waters form a lake often of considerable size. When recently a lake of large size made its appearance in a night, it was the first time in 15 years, according to the railroad officials, that the phenomenon had occurred.

Near Laguna station on the same line of railroad, 160 miles south of El Paso, similar conditions obtain. A short time ago the railroad company was compelled to move its track for a distance of seven kilometers on account of the water rising in the central depression in the bolson. Unusually heavy rains in the mountains suddenly brought the water of the Sanz river down in a body never before known. When the railroad was located it was believed that it was at an elevation far above the level of any possible "lake" waters, and far enough away from any future shore line.

In the famous Elephant Butte case which was fought through the United States courts for so many years, some interesting data bearing upon the subject in hand were brought out. One instance is especially worthy of note. The state of Tamanlipas is crossed by the Rio San Juan, a stream of considerable size which flows into the Rio Grande at the city of Camargo. Many years ago, according to the old man who was a witness in the legal case, occurred a great flood in the San Juan valley. It filled full the valley of the Rio Grande, broke over the foot hills and made a long chain of large lakes, from which navigation of the Rio Grande lower down was carried on for a number of years. These lakes, which were formed in dry desert basins in the course of a few days, lasted for a period of 80 years.

New Mexico School of Mines, Socorro,
July 1st, 1903.

Art. XXXVIII.—*Note on the Identity of Palacheite and Botryogen;* by Arthur S. Eakle.

Under the name *palacheite*,* the writer recently described crystals of a deep red ferri-magnesium sulphate, found at the old Redington quicksilver mine, now known as the Boston mine, Knoxville, California. A later investigation of the chemical composition and crystallization of botryogen shows that palacheite is probably very pure and well crystallized botryogen, and therefore not new as supposed. On noting the similarity in composition of the two sulphates, the analogy of the two in crystallization and physical properties was at once apparent.

Owing to the variations shown in the composition of botryogen, different formulæ have been assigned to the mineral, and the one given by Hockauf† and quoted in Dana's System of Mineralogy, namely, $MgFeS_2O_8+Fe_2S_3O_9+18H_2O$, led to the error of overlooking botryogen as being the same substance. Cleve‡ later deduces from his analyses of botryogen the formula $Mg(FeOH)(SO_4)_2.7H_2O$ or $2MgOFe_2O_3.4SO_3 + 15H_2O$, which latter is the same formula given to palacheite.

The analyses of botryogen show varying amounts of other oxides, namely FeO, MnO, CaO and ZnO, which have been regarded as impurities, replacing the MgO or FeO, but the small amount of material spared for the analyses of palacheite did not show the presence of any of these impurities.

The writer collected an abundance of beautiful specimens of the sulphate this summer, during a visit to the mine, and Professor Blasdale of the Chemical Department kindly made special qualitative tests on larger amounts for impurities, with the result that a small amount of manganese, probably less than one-tenth per cent, is present, but no zinc. The material is, therefore, the purest botryogen that has been found.

The axial elements for botryogen and palacheite are as follows:

Botryogen $a:b:c=0{\cdot}6521:1:0{\cdot}5992$; $\beta=117°\,34'$ (Haidinger)
Palacheite $a:b:c=0{\cdot}6554:1:0{\cdot}3996$; $\beta=117°\;\;9'$

The short vertical axis for palacheite was calculated by assuming the most frequently occurring clinodome as $\{011\}$. The corresponding form on botryogen is $\{023\}$, which practically gives the same length of c-axis for botryogen as for palacheite. The only orthodome observed was $\{\bar{2}01\}$, but it is

* Bull. Dept. Geol. Univ. of Cal., iii, 231–236, 1903.
† Zeitschr. Kryst., xii, 240–254, 1887.
‡ Idem, xxviii, 510, 1898.

exceedingly small and seldom occurs. Assuming it as {$\bar{1}01$}, the vertical parameter for palacheite would become 0·7992, which corresponds to the *c*-axis of botryogen, calculated by Hockauf from Haidinger's measurements. Most of the crystals are worthless for the determination of the elements, because of striated and vicinal faces; but the axial elements for palacheite were calculated from the measurements, with the two-circle goniometer, of several very minute crystals which gave good reflections, and it seems probable they are nearer the true values for botryogen than those given by Haidinger.

The excellent cleavage parallel to the clinopinacoid seems not to have been observed on botryogen. This cleavage is more prominent and better than the prismatic cleavage. Very little has been done on the optical properties of botryogen. Hockauf states that the plane of the optic axes lies nearly normal to the prismatic faces. As a matter of fact it is nearly parallel to the edge $110 \wedge 1\bar{1}0$. The analogy of the interfacial angles to those of anorthite, which he mentions, probably means little, as the crystals are undoubtedly monoclinic.

The crystals remain unchanged in ordinary dry air, as the original specimens, exposed in the laboratory, for over a year, have suffered no alteration. Much yellow earthy sulphate, however, accompanied the material recently obtained, which may have been derived from the crystals by exposure to dampness. This yellow coating has a strong astringent taste, like coquimbite, while the taste of the fresh crystals is barely perceptible or none. The yellow coating must be a different sulphate, although Hockauf states that the analyses of the ochre yellow substance and of the red crystals were essentially the same.

An unsuccessful attempt was made with a small amount of the original substance to recrystallize the mineral; with the large amount of material now at hand, further experiments will be made in the hope of obtaining good crystals. The main difficulty is perhaps in keeping the mineral into solution in pure water without the precipitation of the basic sulphate, which so readily forms.

While the name palacheite should be recalled, although the name botryogen is a misnomer for these crystals, the work will stand as a more complete study of the rare sulphate botryogen than has heretofore been possible.

University of California.

Art. XXXIX.—*On Colloidal Gold: Adsorption Phenomena and Allotropy;* by J. C. Blake.

[Contributions from the Kent Chemical Lab. of Yale University—CXX.]

Red and blue colloidal gold solutions have long been known,* the red being changed to blue by the action of electrolytes. Hence, in order to study all of the concurrent phenomena, it is necessary to begin with a red solution. All of the red solutions heretofore described, however, have either contained objectionable impurities, like the acids of phosphorus, or have been very dilute and hard to prepare in stable form with constant properties. I have found that a concentrated red gold solution, free from all these objections, may be prepared by pouring into acetylene water containing ether an ethereal solution of gold chloride dried at 170°. The resulting garnet-colored solution of colloidal gold is exceedingly stable, though quite strongly acid. It is scarcely turbid in ordinary light, but gives the Tyndall effect when a beam of light is thrown into it with a lens. This solution has been investigated with regard to the adsorption phenomena of the gold when precipitated by electrolytes, an investigation attended by some interesting observations on the apparent allotropy of gold.

It should be rememberd that Linder and Picton† and Whitney and Ober,‡ working with colloidal solutions of arsenious sulphide, have found that when such solutions are coagulated by electrolytes, part of the basic radical of the electrolyte is retained by the coagulum, with the liberation of the corresponding amount of free acid in the filtrate. The base thus retained by the coagulum cannot be washed out with water. Since the suspended particles of which the colloidal solutions are made up are known to be negatively electrified, whereas the basic radicals or ions carry a positive charge, the question arises whether the basic radical retained by the coagulated colloid may not be held by reason of the mutual neutralization of these charges, with the formation of a chemical compound or pseudo-chemical compound, thus perhaps affording an indication of the nature of chemical union and proving that the phenomena of the permanent suspension of solid particles in liquids and their subsequent precipitation by electrolytes are essentially electrical, as is assumed in Whetham's§ hypothesis. It was thought that the

* Faraday, Phil. Trans., cxlvii, 145; Pogg. Ann., ci, 313. Zsigmondy, Lieb. Ann., ccci, 29, 361; Zeit. phys. Chem., xxiii, 63.

† Jour. Chem. Soc., lxvii, 63.

‡ Jour. Am. Chem. Soc., xxiii, 842.

§ Jour. of Physiol., xxiv, 288; Phil. Mag., xlviii, 474.

results to be obtained with colloidal gold solutions would be especially interesting in this connection, both because of the great improbability of ordinary chemical union between the gold and the basic radicals, and because of the ease and thoroughness with which the precipitated gold could be washed.

Red colloidal solutions of gold prepared according to the method just described were precipitated by solutions of barium compounds, and the coagulum was analyzed for gold, barium, and carbon, derived from the acetylene. Except when otherwise stated, all the filtrations and weighings were made on asbestos felt contained in a perforated platinum crucible. The mixed coagulum, either washed or unwashed, was ignited in a porcelain crucible and then treated with aqua regia in small amount either at the ordinary temperature or on the steam bath, the carbon being nearly all dissolved in the latter case. After dilution, the undissolved carbon was filtered off, washed, dried at 200°, weighed and ignited. The gold was determined as the metal in the filtrate from the carbon by precipitation with magnesium ribbon. The barium was precipitated as sulphate in the filtrate from the gold and weighed after standing twelve hours on the steam bath.

It was found that if the colloidal gold solution contained a little unreduced gold chloride, the coagulum was coherent, spongy, opaque, insoluble in water, and reflected brownish yellow light. If, however, the gold chloride had been completely reduced, the coagulum was blue-black, non-coherent, readily soluble in pure water to a blue colloidal solution, the color being due to transmitted light.

I. *The Spongy Form of Gold.*

In the following experiments the gold chloride used in preparing the colloidal gold solution was not quite all reduced, and the colloidal gold, precipitated with a solution of a barium salt, came down in the spongy form. The coagulum was either washed in succession with the amounts of water given in the table, the included liquid being finally pressed out of the spongy precipitate as much as possible, or the coagulum was not washed, but merely dried between filter papers. For purposes of comparison the amounts of the barium compounds (calculated as hydroxide) which were present in $0{\cdot}5^{cm^3}$ of the supernatant liquid are also given in the table.

TABLE I.

Vol. of gold sol. cm³.	Precipitant.	Wash water cm³.	Mixed coagulum, ignited. grm.	Gold found. grm.	$Ba(OH)_2$ found. grm.	Calc. amt. of $Ba(OH)_2$ in 0·5 cm³ supernatant liquid. grm.	Error of analysis. grm.
550	50 cm³ $\frac{n}{10}-Ba(NO_3)_2$	300 50	0·4151	0·4151	0·0000	0·0003	0·0000
1200	100 cm³ $n-BaCl_2$	500 100 100	2·2668	.....*	0·0020	0·0033	-----
610	10 cm³ $\frac{n}{10}-BaCl_2$	Not washed. Dried between filter papers.	0·7569	0·7566	0·0000	0·0001	0·0003—
610	100 cm³ $n-BaCl_2$		0·6499	0·6417	0·0066	0·0060	0·0016—†

From the foregoing results it is plain that very little of the barium compound is held by the gold under these conditions, and that the traces thus retained cannot readily be washed out—a condition agreeing exactly with what would be expected if the barium were held as nitrate or chloride dissolved in the liquid mechanically retained by the spongy gold. The obvious physical properties of this spongy gold proved to be identical with those of the gold thrown out from strong solutions of gold compounds by ferrous sulphate or oxalic acid, which is known to be crystalline.‡

II. *The Blue Form of Gold.*

In the following experiments the gold chloride used in preparing the colloidal gold solution was all reduced, and the colloidal gold, precipitated with a solution of a barium compound, came down in the non-coherent blue form. In the experiments given under A (p. 386), the coagulum was washed successively by decantation with the given amounts of hot water without the use of a filter, part of the finely-divided gold thus temporarily re-suspended being washed away. In the experiments given under B, the coagulum was thrown upon an ashless filter (or asbestos felt) held in a large platinum cone, the mother liquor was exhausted by suction, and the barium compound held by the unwashed gold and the filter was determined.

* Gold lost by explosion, presumably owing to the formation of a hydride during reduction by magnesium.

† This error becomes 0·0003—if the barium held by the gold be calculated as the chloride.

‡ Roscoe and Schoelemmer, Treatise on Chemistry, 1898, ii, p. 399.

By comparing the amounts of the barium compounds thus found with the amounts of the barium compounds held by the filter in blank experiments similarly conducted, and with the amounts of the barium compounds held by 1^{cm^3} of the supernatant liquid, a very fair estimate of the amount of the barium compounds held by the gold can be arrived at. In these experiments the amounts of carbon left with the gold after ignition, not readily dissolved in the subsequent treatment with *aqua regia*, first became noticeable, indicating that in the former experiments most of the carbon had been lost by decantation. In the experiments given under C (p. 387), a freshly prepared solution of barium hydroxide, containing about 20^{grm} per liter, was used as the precipitant, the supernatant liquid being still slightly acid; while in the experiments given under D, the barium hydroxide was added to alkaline reaction. The wash-water was neutral to litmus.

The results of Table II (pp. 386, 387) show that as long as the solution is even slightly acid only insignificant amounts of barium are held by the gold, whether washed or unwashed. Other colloidal (blue) gold solutions, prepared by the action of hydrazine hydrate on a water solution of gold chloride, in which the free acid was nearly neutralized by the hydrazine hydrate before the gold was precipitated by barium chloride, gave similar results. When the supernatant liquid becomes alkaline, on the other hand, the amount of barium retained by the gold becomes appreciable. It is probable that none of this amount was due to the presence of barium carbonate, although there was doubtless some barium chloride (formed by the reaction) present with the hydroxide in experiment (12) of the table, owing to the insolubility of the chloride in alcohol. There is, however, no reason to suppose that the amount of barium hydroxide retained by the gold precipitated from alkaline solution is greater than that which would have been retained, owing to the well-known tenacity of free alkalis for solid substances, by any finely-divided insoluble substance under similar conditions of concentration.* In fact, the absence of adsorption phenomena in acid solution and the presence of such phenomena in alkaline solution is in full accord with Van Bemmelen's functional equation for absorption from solution by porous solids

$$C''_{KOH} = f(C'_{K_2SO_4}, C'_{SO_3})$$

where C''_{KOH} is the concentration of the base in the liquid retained by the solid, and C' represents the concentrations of the given substances in the supernatant liquid. C'' increases as $C'_{K_2SO_4}$ increases, and decreases as C'_{SO_3} increases.

* Cf. Van Bemmelen, Zeit. anorg. Chem., xxiii, 364.

Hence, it appears that adsorption phenomena are not pronouncedly concerned, if at all, in the color changes brought about in red gold solutions by electrolytes, or in the subsequent precipitation of the blue or of the spongy gold. Some interesting results might be obtained in this connection by working with neutral red gold solutions, such as might have been prepared by dialysing the ones here described; but it is difficult to see how any such results could be intelligible unless differentiated by a series of parallel experiments from the effects due to the hydrolysis of neutral salts and absorption of the basic radical by porous solids. If these two effects are identical, as suggested by Whitney and Ober, then Whetham's hypothesis can receive no support from the results to be obtained with them.

The "blue gold" precipitated in these experiments is amorphous and has a dark bronze appearance when viewed in reflected light. The three apparently allotropic forms of gold here noted, named according to the colors most readily observed, as in the case of silver,* are the following:

Form of gold.	Color in reflected light.	Color in transmitted light.
"Yellow gold"	Golden	Blue
"Blue gold"	Dark bronze	Blue
"Red gold"	Light golden†	Red

* This Journal [4], xvi, 282 (1903).
† Well seen in the Tyndall effect.

TABLE II.

A. Coagulum washed.

No.	Vol. of gold solution cm^3.	Precipitant.	Treatment of moist coagulum.	Coagulum, ignited. grm.	Gold found. grm.	Carbon found. grm.	$Ba(OH)_2$ found. grm.	Calc. amt. of $Ba(OH)_2$ in supernatant liquid. grm.	$Ba(OH)_2$ in blank. (aver'ges) grm.	Error of analysis. grm.
1	600	100 cm^3 $n-BaCl_2$	*Water.* 500 100	0·3216*	0·3200	------	0·0013	0·5 cm^3 0·0071	----	0·0003—
2	1400	100 cm^3 $n-BaCl_2$	1000 150 20	0·5691	0·5690	------	0·0003	0·0030	----	0·0002+
3	1100	50 cm^3 $2n-BaCl_2$	500 100 100	0·8439†	0·8435	------	0·0004	0·0037	----	0·0000

B. Coagulum unwashed.

4	760	25 cm^3 $\frac{n}{10}-BaCl_2$	Collected on asbestos felt without washing.	0·9271	------	Considerable	0·0009	1 cm^3 0·0003	0·0005	------
5	880	25 cm^3 $n-BaCl_2$		0·8875	------	amounts.	0·0027	0·0024	0·0023	------
6	1000	25 cm^3 $\frac{n}{10}-BaCl_2$	Collected on filter paper without washing.	0·3520	0·3503	Dissolved with the gold, by digestion.	0·0002	0·0002	0·0005	0·0015—‡
7	980	25 cm^3 $n-BaCl_2$		1·3239	1·3161	0·0027	0·0037	0·0022	0·0023	0·0013—‡

* Loss above 80°=0·0032 grm. † Loss above 120°=0·0027 grm. ‡ Attributed to carbon dissolved by the *aqua regia*.

TABLE II—*Continued.*

C. $Ba(OH)_2$ not in excess.

No.	Vol. of gold solution. cm^3.	Precipitant.	Treatment of moist coagulum.	Coagulum, ignited. grm.	Gold found. grm.	Carbon found. grm.	$Ba(OH)_2$ found. grm.	Calc. amt. of $Ba(OH)_2$ in supernatant liquid. grm.	Error of analysis. grm.
			Water.						
8	1000	25 cm^3 $Ba(OH)_2$ sol.	500 200 100	0·1465	0·1463	0·0003	0·0002	0·5 cm^3 0·0003	0·0003 +
9	1000	25 cm^3 $Ba(OH)_2$ sol.	Collected on filter paper without washing.	0·4159	0·4125	0·0022	0·0006	1 cm^3 0·0005	0·0006 —
			D. $Ba(OH)_2$ in excess.						
10	1000	50 cm^3 $Ba(OH)_2$ sol.	500 100 100	0·2545	0·2524	0·0006	0·0019	0·5 cm^3 0·0005	0·0004 +
11	1000	125 cm^3 $Ba(OH)_2$ sol.	100 20 Alcohol	2·4610	.....*	0·0014	0·0104	0·0013	.....
12	1000	100 cm^3 $Ba(OH)_2$ sol.	100 100 100 5	0·8447	0·8306	.....	0·0168	0·0010	0·0027 +‡

* Gold lost by explosion.

† This error becomes 0·0009 + if the barium held by the gold was present as the oxide after ignition, protected from the carbon dioxide of the air by the surrounding gold. Cf. Gmelin-Kraut, Anorg. Chem. II (1), 259.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *The Utilization of Atmospheric Nitrogen for Agricultural and Industrial Purposes.*—In an address before the recent International Congress for Applied Chemistry at Berlin, Dr. Frank stated that we are now in a position, by the help of electric power, to combine the hitherto passive nitrogen of the air and to make it useful for the fertilization of land and for the production of nitrogenous chemical products. The particular process described depends on the fixation of nitrogen by calcium carbide, a product of the electric furnace which is now extensively manufactured. The product of this reaction is not calcium cyanide, as might be expected, but calcium cyanamide :

$$CaC_2 + N_2 = CaCN_2 + C.$$

From this product cyanamide itself is readily prepared, and both substances yield ammonia when heated with water under high pressure :

$$CaCN_2 + 3H_2O = CaCO_3 + 2NH_3$$
$$CN_2H_2 + 3H_2O = (NH_4)_2CO_3.$$

Experiments with plants have been made which indicate that the crude calcium cyanamide will serve very well when used directly as a fertilizer. The substance contains from 14 to 22 per cent of nitrogen, according to the process used for its manufacture, so that it approaches Chili saltpeter and ammonium-sulphate in its richness in this fertilizing element. As an indication of the availability of these substances for plant-food, it may be mentioned that cyanamide, by simply taking up water, is converted into urea :

$$CN_2H_2 + H_2O = CH_4N_2O.$$

The importance of a cheap method of fixing atmospheric nitrogen can hardly be over-estimated, in view of the fact that about three-quarters of the Chili saltpeter and ammonium sulphate are used for agricultural purposes. It may be expected also that the supply of Chili-saltpeter would otherwise soon be exhausted, since the export of this salt from the western coast of South America increased from 68,500 tons in 1860 to 1,453,000 tons in 1900. The world's future food-supply largely depends upon the supply of nitrogenous fertilizers.—*Zeitschr. angew. Chem.*, xvi, 536. H. L. W.

2. *The Use of Calcium Cyanamide for Producing Alkaline Cyanides.*—The production of calcium cyanamide has been described in the preceding notice. At the recent International Congress for Applied Chemistry at Berlin, Dr. G. Erlwein has explained the use of this new material in the manufacture of cyanides. He states that calcium carbide, with proper treatment, can be made to take up from 85 to 95 per cent of the theoretical amount of

nitrogen when heated in a muffle with fuel instead of being heated in an electric furnace. The black product, containing lime and carbon as impurities, impure calcium cyanamide with 20 to 23½ per cent of nitrogen, can be treated for the production of cyanides in various ways. It has been found possible, however, to produce the calcium cyanamide by a single operation in the electric furnace according to the equation,

$$CaO + 2C + N_2 = CaCN_2 + CO.$$

This direct process is more economical than the indirect one by means of calcium carbide, and it will be of great practical importance not only for the production of cyanides, but also for the preparation of the substance for fertilizing purposes.

It was found that calcium cyanamide, by a simple leaching process, yields crystallized dicyandiamide:

$$2CaCN_2 + 4H_2O = 2Ca(OH)_2 + (CNNH_2)_2.$$

The latter salt, then, by a simple fusion process, gives pure alkaline cyanides:

$$4CNNH_2 + 2Na_2CO_3 + 4C = 4NaCN + 2NH_3 + H_2 + 6CO + N_2$$

Another important result is the production of a substitute for potassium cyanide, to be used in gold extraction, by fusing crude calcium cyanamide with common salt. The product corresponds to 30 per cent potassium cyanide, is extraordinarily cheap, and answers the purpose as well as the pure salt.—*Zeitschr. angew. Chem.*, xvi, 533. H. L. W.

3. *The Separation of Gaseous Mixtures by Centrifugal Force.*—In the preceding number of this Journal a process for separating gases of different density by centrifugal force was noticed. It seemed necessary, therefore, to mention here the fact that Claude and Demoussy have reached the conclusion that this method produces only very slight results, if, indeed, there is any separation at all. These experimenters used a strong steel tube about 50^{cm} long and 3^{cm} in internal diameter, provided with stopcocks at the ends and with interior spring-valves near the ends. The tube was charged with gaseous mixtures under pressure, so that the differences in density were augmented, then it was rotated about an axis perpendicular to its center at the rate of 3600 revolutions per minute. It did not seem prudent to exceed this speed, which was greater than that used in the industrial machines that have been referred to. The internal valves were adjusted by springs in such a way that they opened by the action of centrifugal force, and closed tightly after the speed became slower. Analyses showed that the gases collected beyond the valves after rotation did not differ appreciably from the original mixtures in the cases of air, oxygen and carbon dioxide, and even hydrogen and carbon dioxide.—*Comptes Rendus*, cxxxvii, 250. H. L. W.

4. *Investigations on Double Salts by Physical Means.*—Dr. H. W. Foote of the Sheffield Laboratory has devised a method for determining what double salts are formed by two single salts with a common ion. The method depends chiefly on well-known

principles of solubility. At a given temperature there will be but one saturated solution possible when both salts are present in excess, provided the salts form no double salts with each other. If one double salt forms, there will be two definite saturated solutions, one when A and AB are both present as solids, the other when AB and B are present. The single salts alone or a double salt alone can exist in contact with a series of saturated solutions containing A and B. It follows that when two salts, either simple or double, are present in the solid state the composition of the solid will change as the relative proportion of the two salts changes, but the composition of the saturated solution will remain constant. When, however, only one salt, either simple or double, is in the solid state its composition must remain fixed, while the composition of the saturated solution varies within certain limits. By making a series of saturated solutions with a pair of salts, therefore, and determining the composition of the solutions and the residues, it is possible to determine the composition of every double salt that is formed. Dr. Foote has applied the method in several cases with entirely satisfactory results; for instance, he has shown that five cæsium mercuric chlorides, and no others, exist at the temperature of the experiments. These salts, $3CsCl.HgCl_2$, $2CsCl.HgCl_2$, $CsCl.HgCl_2$, $CsCl.2HgCl_2$ and $CsCl.5HgCl_2$ were described by Wells in this Journal in 1892. The method, which is an application of the Phase Rule of the late Professor Gibbs, promises to be exceedingly serviceable in the investigation of double salts, for by its use every double salt, whether well-crystallized or not, can be detected, while by the old method some members of a series might easily be overlooked.—*Amer. Chem. Jour.*, xxx, 330, 339.

H. L. W.

5. *Ausgewählte Methoden der Analytischen Chemie;* von Prof. Dr. A. Classen. Zweiter Band, 8vo, pp. xvi, 831. Braunschweig 1903 (Vieweg und Sohn).—The first volume of this excellent reference-book for practical analysts has already been noticed in this Journal. The present second volume deals with the non-metallic elements, and it need only be repeated here that every analytical chemist should have access to this valuable work.

H. L. W.

6. *Physical Chemistry in the Service of the Sciences;* by Jacobus H. van't Hoff. English version by Alexander Smith. 8vo, pp. 150, Chicago 1903. (The University of Chicago Press.) —This book comprises a series of nine lectures delivered in June, 1901 at the decennial celebration of the University of Chicago. The subjects discussed, after an introductory address, are the relation of physical chemistry to pure chemistry, industrial chemistry, physiology and geology. In view of the eminence of the author it is hardly necessary to say that these lectures give an excellent account of the more important achievements of physical chemistry.

H. L. W.

7. *Penetrative Solar Radiations.* — M. R. Blondlot believes

that he has discovered new radiations from the sun which he terms the *n*-rays. A fine glass tube containing sulphide of calcium exposed to the sun for a very short time continued to glow, but the glow diminished when a plate of lead was interposed between the shutter and the sulphide, and increased when the lead was removed. When an oaken joist 3^{cm} thick, a piece of cardboard, and several sheets of aluminum were successively interposed there was no diminution in the glow. A layer of pure water entirely arrested the *n*-radiations. The radiations could be concentrated by a quartz lens. They are regularly reflected by a polished glass surface, and diffused by an unpolished surface. —*Comptes Rendus*, 24. *Nature*, July 9, 1903. J. T.

8. *Spectra of the Cathode light in Gaseous Compounds of Nitrogen and Carbon.*—M. H. Deslandres states that the cathode light gives the same spectrum as the anode light in the luminous part of the spectrum and also between $\lambda = 400$ and $\lambda = 300$, but from $\lambda = 300$ to $\lambda = 200$ a new band spectrum is observed having a remarkably simple relation between its bands. —*Comptes Rendus*, Sept. 14, 1903. J. T.

9. *The Dark Cathode Space.*—Numerous papers have appeared on the analogy between conduction in gases and electrolytic conduction in fluids. G. C. Schmidt extends the analogy to a consideration of the phenomena in the dark cathode space and founds a theory upon Nernst's theory of the electrolysis of certain water solutions. A soluble electrode is one which sends electrons or ions into the gas; an insoluble one which cannot. White hot electrodes and electrodes from which cathode rays are emitted are considered soluble; also light electric metals that emit electrons on exposure to light. This theory is borne in mind in the author's experiments. The dark cathode space is regarded as a space poor in ions. The fall in potential is also considered from the view of the poverty or affluence of ions. The poverty extends to the cathode itself, while the anode possesses the abundance. The cathode dark space behaves as a dielectric, and does not screen electric waves.—*Ann. der Physik.*, No. 11, pp. 622–652. J. T.

10. *Observations of Slow Cathode Radiations with the help of Phosphorescence.*—P. Lenard contributes an exhaustive paper on this subject, and also upon secondary excitation of cathode rays. He gives his reasons for preferring the employment of phosphorescence to the use of the electrometer. The former serves to individualize the phenomena, while the latter gives the integral effect. He introduces the new term *Quanten* to denote the corpuscle or portion of negative electricity. The path of the *Quanten* is a cathode ray. Electrically laden atoms he terms bearers of electricity or *Träger*. Ultra-violet rays pass into a suitable tube, where they are submitted to varying differences of electric potential, and the spreading out of the rays is observed on a phosphorescent screen, contained in the same tube. Various phenomena are described and theories of absorption of energy

are discussed. It was found that the secondary excitation of cathode rays is not due to a splitting up of the molecule in an electrolytic sense. The question is discussed whether the bearers of electricity are bound to the material gas particles, and whether the light electric phenomena are due to double layers on material in air which subsist for a long time in a vacuum.—*Ann. der Physik.*, No. 11, 1903, pp. 450–490. J. T.

11. *Discharge of Electricity from Hot Platinum.*—HAROLD A. WILSON, of Trinity College, Cambridge, finds that the presence of traces of hydrogen in platinum wire enormously increases the leak of negative electricity from it. The presence also of traces of phosphoric pentoxide greatly increased this leak. The variation of the negative leak with air pressure and potential difference is due to the ionization of the air by collisions of air molecules with the negative ions leaving the wire.—*Roy. Soc.*, June 18, 1903; *Nature*, July 16, 1903. J. T.

12. *Penetrating Radiation from the Earth's Surface.*—Mr. H. LESTER COOKE of McGill University, Montreal, working under the direction of Prof. Rutherford, gives as the results of his investigation:

"(1) The proof of the existence of a very penetrating radiation, present everywhere under ordinary conditions. This radiation is similar in properties to the radiation from radium, and is comparable to it in penetrating power. This radiation is accountable for between 30 and 33 per cent of the natural ionization observed in ordinary testing vessels, 33 per cent being the greatest reduction obtained by the use of massive lead screens. This penetrating radiation may have its origin in the radio-active matter which is distributed throughout the earth and atmosphere. It was not found possible to obtain sufficient excited activity on a wire charged negatively in the open air to show the presence of a very penetrating radiation due to it. The effect observed is too large to be accounted for by the excited activity distributed on the walls of the laboratory.

(2) That all substances examined give forth a radiation of a not very penetrating character: that this is probably the cause of all the residual ionization in the electroscope when surrounded by heavy metal screens; and that this activity varies with different substances, being very low in the case of brass.

(3) The reduction by the experimental arrangements of the number of ions produced per c.c. per second in air under atmospheric pressure from 14 to 5."—*Phil. Mag.*, Oct., 1903, pp. 403–411. J. T.

13. *Mathematical Papers of the late George Green.* xii + 336 pp. Paris, 1903 (A. Hermann).—This is a fac-simile reprint by photographic process of Ferrers' edition of Green's Papers and is to be welcomed as increasing their accessibility to students of mathematical physics. There is no better introduction to the theory of electrostatics and the Newtonian potential in general than the celebrated paper of 1828 in which the name potential

was first used and in which the great utility and preëminent importance of this function was first made plain. Few, if any, improvements in the presentation of the general theory have been made in the seventy-five years since its publication, and it has all the advantage of being the original work of a great genius and of showing in a measure the processes by which he reached his results. That such a work should have been produced by a young man without any mathematical training except what he could gain for himself is one of the most interesting chapters in the natural history of genius. Some of the other papers are of less direct interest at the present day; that on the propagation of light in crystallized media, however, is still the foundation of the theory of the elasticity of æolotropic solids and cannot be neglected by the student who desires a comprehensive knowledge of the history of this important subject.

H. A. B.

14. *Electric and Magnetic Circuits;* by ELLIS H. CRAPPER. xi+379 pp. New York, 1903 (Longmans, Green and Co.).—The plan of this elementary text-book for students of electrical engineering is not unlike that of the school arithmetics in which a large number of numerical examples are propounded for solution by the student, each collection of problems bring prefaced by a brief statement of the "rules" necessary for solving them, and by two or three worked-out examples. The explanatory portions leave much to be desired especially in the more elementary sections. The definitions are often inaccurate and sometimes quite meaningless, as on p. 3 where the ampere is defined as "the time rate of change of the coulomb per second." The explanations often give entirely wrong ideas of the relations between electrical quantities and of the laws which express them, as in the discussion of E.M.F. and P.D. on pp. 34 and 35 and the curious statement on p. 39 that the constant ratio of the E.M.F. to the current "was discovered by Ohm to be equal in all cases to the total resistance of the circuit". Most of the formulae used for solving the problems are introduced as depending directly upon experiment with no indication that they might easily be deduced from preceding ones; it is hard to believe that there is any very large number of students of electricity so deficient in logical memory as to find this method easier and more "practical" than an orderly and logical presentation. A still more serious defect, in a book primarily intended to teach engineers to calculate, is that no attention is paid to the limits of accuracy in data and results. In the illustrative examples, currents and resistances are calculated to six or seven significant figures, the cost of incandescent lights per candle-hour is determined to the ten-millionth of a penny, and in one case (p. 306) the torque exerted by a motor is calculated to eleven figures from data given to four figures. Such calculations cannot be regarded as good models for imitation by future engineers.

H. A. B.

II. Geology and Mineralogy.

1. *United States Geological Survey:* C. D. Walcott, Director.—The following publications have recently been received:

Folios No. 92. Gaines Folio, Pennsylvania-New York.

No. 93. Elkland-Tioga Folio, Pennsylvania; by Myron L. Fuller and William C. Alden.

These folios are specially interesting as an expression of the revision of classification of the terminal Devonian formation of the New York-Pennsylvania area based on recent surveys. The classification adopted is as follows:

Carboniferous	Pennsylvanian	Pottsville	30′–200′
		Sharon conglomerate	60–100′
		Mauch Chunk	0–100′
	Mississippian	Oswayo	1000′
Devonian		Cattaraugus	500′
		Chemung	600–2000′+.

The definition of the formations is based upon lithologic characters. In describing the Chemung on the Gaines quadrangle the author says: "It should be clearly distinguished from the paleontologic division called Chemung which includes both the marine fauna of the lithologic Chemung and the fresh and brackish water fauna of the overlying Cattaraugus and lower portion of the Oswayo formations." In other words, the Chemung fauna may be regarded as ranging above the Chemung formation and as high as the lower part of the Oswayo formation.

Lithologically the Chemung is limited below by the bluish shales of the Portage, not reached in these quadrangles, and above by the red shales of the Cattaraugus. Soft laminated shales predominate; limestones predominate in upper part; the thickest beds in the upper 100 or 200 feet. A single bed of bright red shale is reported? 300 feet down in the Tioga quadrangle, and a thin lens of iron ore at same level, with dull reddish brown shales still lower. A bed of gray cross-bedded sandstone of Cattaraugus type is reported 60 or 100 feet below the top. Vertical worm borings, concretions of sand, and a few thin lenses of conglomerate are seen in the upper part of the formation. Two horizons of iron ore beds are seen, one "close to the top," the second 300 feet or more down. The upper is the "Mansfield" ore beds a few feet below the first red bed of the Cattaraugus. Chemung character of rock and fossils are said to occur for 50 to 100 feet after the reds of the Cattaraugus first appear.

The limits of the Cattaraugus are given as from the first pronounced red beds upward for 500 feet, the upper limit arbitrarily drawn. The red beds are thicker in the southeastern portion of the area and are thinner and more widely separated by more pro-

nounced beds of other kinds to the west and northwest. Cross-bedding is conspicuous. This corresponds in general to the formation which has been called the red Catskill.

Oswayo is characterized by green and gray sandstones and shales with occasional thin beds or lenses of red shale from the arbitrary top limit of the Cattaraugus to a point at which decidedly red beds begin to appear about 1100 feet higher up. These beds are also more or less cross-bedded.

The Mauch Chunk includes from the lowest recognized red bed overlying the Oswayo for 100 feet upward or less, and is terminated above by an unconformity.

The Pottsville formation is described in the text as including the Sharon conglomerate member at the base, 60 to 100 feet in thickness, almost entirely quartz, "and is frequently a coarse sandstone rather than a conglomerate." The upper portion is more sandy and shaly than the lower and with one or more coal seams; the fossil plants in which have been identified with those of the Mercer horizon of the Pottsville.

It is evident from these definitions that the limits set for the formations are both local and arbitrary ; and as the characters used in drawing the lines are recognized as varying across the area mapped in these two contiguous folios, it is not probable that formations based on the same criteria of discrimination will agree in stratigraphic position for many miles either side of this area. H. S. W.

2. *Geological Survey of Canada:* Robert Bell, Director.— The following reports have recently been issued :

No. 797. Report on the Cambrian Rocks of Cape Breton; by G. F. Matthew. 246 pp., 18 pls.

No. 821. Report of the Section of Chemistry and Mineralogy; by G. Christian Hoffmann, pp. 1 R to 67 R.

No. 822. Catalogue of Canadian Birds, Part II. Birds of prey, woodpeckers, flycatchers, crows, jays and blackbirds, including the following orders : Raptores, Coccyges, Pici, Macrochires, and part of the Passeres ; by John Macoun. 413 pp.

No. 827. Mesozoic Fossils, Vol. I, Part V (and last). On some additional fossils from the Vancouver Cretaceous with a revised list of the species therefrom ; by J. F. Whiteaves, pp. 309–416, and pls. 40–51.

In the first of these reports Dr. Matthew gives details of the Coldbrook and Etcheminian terranes, and the fossils found in them and of their relation to the Laurentian upper series. The results of an interesting investigation of the orientation of brachiopod shells are reported from which the direction of the current during their burial is estimated, based upon a large number of observations upon the shells of numerous genera. The shells of *Acrothyra* furnish the most satisfactory evidence. Mr. Macoun contributes a second part to his catalogue of Canadian birds ; the third is announced as almost ready for printing.

Doctor Whiteaves completes, in the contribution here listed, his valuable Memoir upon the Cretaceous Rocks of Vancouver.

The present volume contains the detailed description of collections made from these rocks since 1871. H. S. W.

3. *Elements of Geology:* A text-book for colleges and for the general reader; by JOSEPH LECONTE, revised and partly rewritten by HERMAN LEROY FAIRCHILD. 5th edition, revised and enlarged. 667 pp., 1002 figs. 1903. (D. Appleton & Co.)—The revising author makes special mention of the adoption in this volume of Professor Chamberlin's Planetesmal Hypothesis of the Origin of the Earth, stating that "recent studies discredit the nebular hypothesis" which has long held a prominent place in geology. Other new points of view resulting from the general progress of science are noted, and the illustrations are augmented by a number of original views reproduced by photography of typical geological features, and, as is stated in the reviser's preface, "the spirit and style of the revered author have been held as the model," and successfully. H. S. W.

4. *Chemical Analyses of Igneous Rocks; Published from 1884–1900, with a Critical Discussion of the Character and Use of Analyses;* by H. S. WASHINGTON. U. S. Geol. Surv. Prof. Paper 14, Washington, 1903, 4°, 495 pp.—This is a publication whose appearance will be gladly welcomed by petrographers, chemists and geologists interested in the chemistry of rocks. Since the time of Roth, whose collected tables were so long an invaluable aid in petrographic investigations, no such adequate collection as the one before us has appeared. The work begins with a discussion of the methods of making analyses and a just emphasis is laid upon the considerable amount of poor or incomplete work which is often done in this direction. A basis for the rating of analyses according to their completeness and accuracy is described and all of those in the tables are rated according to the standards adopted. Following this method the whole number is divided into two sets of tables—"superior analyses," of which 1987 are given, and "inferior analyses," of which there are 984. The superior analyses are classified according to the new quantitative system recently proposed by Cross, Iddings, Pirsson and Washington, and thus serve as a most complete exposition of this system. In all these cases the calculated "norm" of the system is given with each analysis. The inferior analyses are classified according to prevailing systems, that is they are grouped under the names with which they have been published. With all analyses the locality of the rock, the name of the analyst and the reference in the literature are given, and usually some appended remarks containing useful information. The accompanying text contains also an interesting discussion of the information thrown on the new system of classification by the generalized facts which the collection affords. The whole evinces the results of a vast amount of patient and unwearied industry in the search through the literature and in the collating and reducing to form of the material collected. Its value is greatly enhanced by a very complete system of indexes, to new rock names, to old rock names, to localities, to the text, and there is

also a glossary of the terms of the new classification. The work cannot fail to exert a permanent influence on the advancement of petrographic science. L. V. P.

5. *Californite* (*Vesuvianite*),* — a new ornamental stone; by GEORGE F. KUNZ. (Communicated.) — A discovery has been recently made in California of a mineral which promises well as an addition to the increasing list of semi-precious or ornamental stones found in the United States. It is not indeed a new mineral species, but a compact massive variety of vesuvianite (idocrase). The discovery was first announced in the report of the U. S. Geological Survey for 1901, by the writer.† The mineral was found by Dr. A. E. Heighway, on land owned by him on the South Fork of Indian Creek, 12 miles from Happy Camp and 90 miles from Yreka, in Siskiyou County. Here a hard and handsome stone, varying from olive- to almost grass-green, and taking a fine polish, outcrops for some 200 feet along a hillside about 100 feet above the creek, and large masses have fallen into the bed of the creek below. It was at first supposed to be jade (nephrite), but proves upon analysis to be vesuvianite. The fallen pieces were in some cases as much as five feet square and two feet thick, of excellent quality for polishing, and of varying shades of light to dark green. The associated rock is precious serpentine.

This substance closely resembles a mineral from the south side of the Piz Longhin, in the Bergellthal, also found in rolled pieces in the bed of the stream called the Ordlegna, near Casaccia, in the Upper Engadine. These were at first taken for jadeite,‡ but were positively identified as vesuvianite by the analysis of Berwerth.§ It seems at first remarkable that the same mistake should have been made in both cases as to this massive vesuvianite, but its whole aspect is so jade-like that it is not surprising. The rich translucent green color, fine-grained subsplintery fracture, and brilliant luster when polished all strongly suggest jade. The polished surface shows minute pale streaks or flocculi, which still further heighten the resemblance.

The following analysis was made through Prof. F. W. Clarke, chief chemist of the U. S. Geological Survey, by Mr. George Steiger, in the spring of the present year.

ANALYSIS OF VESUVIANITE, FROM SISKIYOU CO., CALIF.

SiO_2	35·85	TiO_2	0·10	
Al_2O_3	18·35	P_2O_5	0·02	
CaO	33·51	H_2O	0·29	below 100° C.
Fe_2O_3	1·67	H_2O	4·18	above 100° C.
FeO	0·39			
MgO	5·43		99·85	
MnO	0·05			

* N. Y. Acad. Sciences, Oct. 19, 1903; N. Y. Min. Club, Oct. 20, 1903.
† Mineral Resources of the U. S. (extract), p. 30.
‡ Fellenberg, Jahrb. Min., vol. i, 1889, p. 103.
§ Ann. Mus. Wien, vol. iv, 1889, p. 87.

The analysis is essentially that of a normal vesuvianite, though the percentage of water is unusually high; the lime and the iron are below the average; the titanium and phosphorus are exceptional occurrences.

The mineral is compact, of remarkable toughness, and readily admits of a fine polish, quite as high and beautiful as that of nephrite (jade), with which it was at first confounded. It is subtranslucent to faintly translucent, with very weak double refraction. The hardness is 6·5, and the specific gravity (from two determinations) 3·286. The luster is vitreous, often inclining to resinous, and the streak white. The color is a yellow leek-green, with inclusions of a darker green, generally more translucent than the surrounding mass.

This interesting mineral exists in large quantity, and could be cut into a variety of ornaments, in the same way as jade, nephrite and chrysoprase. It is a form of vesuvianite distinctive enough to warrant giving it a special variety name,—which, if appropriate and euphonious,, would undoubtedly aid the sale of the stone in the arts. I therefore propose the name "*Californite*" for this massive, translucent mineral,—which occurs in quite a range of colors, from almost white to pale green, leek-green, even dark grass-green shades.

What appears to be the same mineral has recently been announced from two other localities quite remote from the first. One of these was reported by that indefatigable prospector, Mr. M. Braverman, of Visalia, as existing in Burro valley, in Fresno County, a mile and a half from Hawkins school house, and 32 east of Fresno city. The material is pale olive-green, translucent, with darker spots in a paler mass. It breaks with an uneven fracture, slightly splintery and partly crystalline, and hence much resembles the Siskiyou County material.

The other locality is apparently not very distant from the last mentioned; it is said to be in Tulare County, near the town of Selma, which though in Fresno County, is not far from the Tulare line. Here the mineral is of even a richer color, at times resembling the tint of apple-green chrysoprase for which it was at first mistaken.

6. *Native Bismuth and Bismite from Pala, California;* by George F. Kunz. (Communicated.)—The remarkable locality at Pala, San Diego Co., California, noted for its colored tourmalines and other lithia minerals, has now been found to yield also native bismuth in considerable abundance, and likewise the oxide, bismite. Specimens have lately been received by me through the courtesy of Mr. W. H. Crane, of the American Lithia Co., of New York. Overlying the great mass of amblygonite at the lepidolite mine (described in this Journal for September, 1903) is a heavy capping of coarse granite, throughout which both metallic bismuth and bismite are present in more or less profusion. The latter appears as a coating of an orange-yellow to grey color, permeating the quartz and associated minerals, and between the

crystalline platy masses of the bismuth, from which it is unquestionably derived. The native bismuth is generally in long irregular crystals, always forming a capping over another mineral, evidently tourmaline; it also appears in platy crystalline masses, several millimeters in length and breadth, up to 12 or 15. The characteristic pinkish tin color is well shown in a cut section, and on the pronounced *c* faces of cleavage. One bismuth crystal, an inch in length, was evidently a pseudomorph or replacement of bismuth after a feldspar (?). The hardness is a little above 2.

7. *The Production of Precious Stones in 1902;* by GEORGE F. KUNZ. Extract from Mineral Resources of the United States, U. S. Geological Survey, Washington, 1903.—This report gives an interesting summary of the production of the various gems and ornamental stones throughout the world with particular reference to this country. The total importation of precious stones into this country amounted in 1902 to nearly $25,000,000. The comparative table for the years 1896 to 1902 shows that in that period the production of sapphire in this country increased from $10,000 to $115,000; of tourmaline from $3,000 to $30,000; of turquoise from $40,000 to $130,000. No diamonds have been found in this country during 1902, but the production in South Africa was large, aggregating upwards of four million pounds sterling. It is noted as a matter of curiosity that a cubic meter of diamonds from the De Beers Mine was found to weigh 11,976,000 carats and had the approximate value of about $76,000,000.

An interesting account is given of the production of diamonds and carbons (carbonado) in Bahia, Brazil, and a description is given of some very large masses of carbon found there. The largest of these, found in 1895, weighed 3,078 carats; another, found in 1894, weighed 975 carats and a third was found in 1901 weighing 750½ carats.

III. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Report of the U. S. National Museum under the direction of the Smithsonian Institution for the year ending June 30, 1901.*—This volume gives the reader a good knowledge of the activity in the work of the National Museum at Washington, the conduct of which is one of the important functions of the Smithsonian Institution. It contains the report of the Assistant Secretary in charge of the Museum, Mr. Richard Rathbun, with also those of W. H. Holmes, Curator in the Department of Anthropology, of F. W. True, Curator of Biology, and of G. P. Merrill, Curator in Geology. Among the special papers accompanying the volume is one giving a full account of the exhibit of the Museum at the Pan-American Exposition illustrated by many plates; another on flint implements and fossil remains from a Sulphur Spring at Afton, I. T., by W. H. Holmes; on archæological field work in northeastern Arizona by Walter Hough; a

narrative of a visit to Indian tribes of the Purus River, Brazil, by J. B. Steere.

The Afton Sulphur Spring is remarkable for the fossil remains discovered in its immediate neighborhood. These are chiefly the teeth of the mastodon and the mammoth, also teeth of the fossil bison and horse ; with them occur bones of some recent animals. Stone and bone implements were also found in large numbers in the spring. The conclusion is reached that these deposits owe their existence for the most part to the superstition of the Indians who by their offerings sought to propitiate the spirits of the spring.

2. *The Fauna and Geography of the Maldive and Laccadive Archipelagoes ;* edited by J. STANLEY GARDINER. Vol. II, Part I, pp. 492–588, 9 pls. (See this Journal, xiii, 321 ; xiv, 74 ; xv, 240, 488.)—This part includes the results of the studies of some of the smaller collections of the expedition: Alcyonarians, Nudibranchs, Sponge-crabs, Land Planarians, and Lagoon Deposits; these are by Professor S. J. Hickson, Miss Edith M. Pratt, Sir Charles Eliot, Messrs. L. A. Borradaile, F. F. Laidlaw, J. Stanley Gardiner, and Sir John Murray. Professor Hickson found the alcyonaria to be of more than ordinary interest, as the specimens were obtained from a considerable number of dredgings made in several localities over an extensive area, thus affording an opportunity for a study of the variation in form, color, and other features ; hitherto a species often having been founded on a single specimen or on a few from a single locality. Miss Pratt gives valuable results of anatomical investigations and comparative studies of four genera of the group: *Sarcophytum*, *Lobophytum*, *Sclerophytum*, and *Alcyonium*. K. J. B.

3. *Catalogue of the Collection of Birds' Eggs in the British Museum (Natural History)*, Vol. III ; by EUGENE W. OATES, assisted by Capt. SAVILLE G. REID. Pp. xxi, 349 with x plates. London, 1903.—This third volume includes 907 species belonging to the Carinatæ (Psittaciformes-Passeriformes) ; it corresponds to volumes II and III, already issued, of Dr. Sharpe's Hand-list of the Genera and Species of Birds.

4. *A Hand-list of the Genera and Species of Birds ;* by R. BOWLDER SHARPE. Vol. IV, pp. xii, 391. London, 1903.—The list of known species of Passeriformes down to the end of the Certhiidæ are included in this volume. It is announced that the whole work will be completed with the issue of a fifth volume, which will probably be published in the course of a few months.

5. *Cold Spring Monographs, Nos. I and II.*—These monographs give the results of work done at the Biological Laboratory of the Brooklyn Institute of Arts and Sciences at Cold Spring Harbor, L. I. No. I, by Mabel E. Smallwood, is on the Beach Flea, *Talorchestia longicornis*, with three plates and three text-figures. No. II, by C. B. Davenport, is on the Collembola of Cold Spring Beach with special reference to the movements of the Poduridæ, with one plate.